UNITED STATES
SECURITIES AND EXCHANGE COMMISSION
Washington, D.C. 20549

FORM 10-K

(Mark One)

☒ **ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**

For the fiscal year ended December 31, 2019

OR

☐ **TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**

For the transition period from __________ to

Commission file number: 001-36481

ASPEN AEROGELS, INC.
(Exact name of registrant as specified in its charter)

Delaware **(State or other jurisdiction of incorporation or organization)**	**04-3559972** **(I.R.S. Employer Identification No.)**
30 Forbes Road, Building B **Northborough, Massachusetts** **(Address of principal executive offices)**	**01532** **(Zip Code)**

Registrant's telephone number, including area code (508) 691-1111
Securities registered pursuant to Section 12(b) of the Exchange Act:

Title of each class	Trading Symbol	Name of exchange on which registered
Common Stock, par value $0.00001 per share	ASPN	New York Stock Exchange

Securities registered pursuant to Section 12(g) of the Exchange Act: None

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes ☐ No ☒

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Exchange Act. Yes ☐ No ☒

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes ☒ No ☐

Indicate by check mark whether the registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§232.405 of this chapter) during the preceding 12 months (or for such shorter period that the registrant was required to submit such files). Yes ☒ No ☐

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, a smaller reporting company, or an emerging growth company. See the definitions of "large accelerated filer", "accelerated filer," "smaller reporting company," and "emerging growth company" in Rule 12b-2 of the Exchange Act.

Large accelerated filer	☐	Accelerated filer	☒
Non-accelerated filer	☐	Smaller reporting company	☒
		Emerging growth company	☐

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act. ☐

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act). Yes ☐ No ☒

The aggregate market value of the registrant's common stock held by non-affiliates of the registrant (without admitting that any person whose shares are not included in such calculation is an affiliate) computed by reference to the price at which the common stock was last sold as of the last business day of the registrant's most recently completed second fiscal quarter was approximately $166.3 million.

As of March 5, 2020, the registrant had 26,594,455 shares of common stock outstanding.

DOCUMENTS INCORPORATED BY REFERENCE

Portions of the registrant's definitive Proxy Statement for its Annual Meeting of Stockholders to be held on June 18, 2020 are incorporated by reference into Part III of this Annual Report on Form 10-K to the extent stated herein.

TABLE OF CONTENTS

PART I

Item 1. BUSINESS

Aspen Aerogels, Inc. is an aerogel technology company that designs, develops and manufactures innovative, high-performance aerogel insulation used primarily in the energy infrastructure and building materials markets. The Company also conducts research and development related to aerogel technology supported by funding from several agencies of the U.S. government and other institutions. When used in this report, the terms “we,” “us,” “our” and “the Company” refer to Aspen Aerogels, Inc. and its subsidiaries.

We design, develop and manufacture innovative, high-performance aerogel insulation. We believe our aerogel blankets deliver the best thermal performance of any widely used insulation product available on the market today and provide a combination of performance attributes unmatched by traditional insulation materials. Our products provide two to five times the thermal performance of widely used traditional insulation in a thin, easy-to-use and durable blanket form. Our end-use customers select our products where thermal performance is critical, and to save money, improve resource efficiency, enhance sustainability, preserve operating assets and protect workers.

Our technologically advanced products are targeted at the estimated $3.1 billion annual global market for energy infrastructure insulation materials. Our aerogel insulation has undergone rigorous technical validation and is used by many of the world’s largest oil producers and the owners and operators of refineries, petrochemical plants, liquefied natural gas facilities and power generating and distribution assets, such as ExxonMobil, PTT LNG, Dominion Resources and Royal Dutch Shell. Our products replace traditional insulation in existing facilities during regular maintenance, upgrades and capacity expansions. In addition, our aerogel products are increasingly being specified for use in new-build energy infrastructure facilities.

We introduced our two key product lines, Pyrogel and Cryogel in 2008. Our product revenue has grown from $17.2 million in 2008 to $136.9 million in 2019, representing an eleven year compound annual growth rate of 21%. During this period, we have sold more than $958 million of our products globally, representing an installed base of more than 354 million square feet of insulation. We believe that our eleven year track record of success positions us for future growth and continued gain in market share.

We currently focus our commercial efforts in the energy infrastructure market, where we believe our products have multiple high value applications. We also market and sell aerogel products for use within the building materials and other end markets. Customers in these markets use our products for applications as diverse as wall systems, military and commercial aircraft, trains, buses, appliances, apparel, footwear and outdoor gear. As we continue to enhance our aerogel technology platform, we believe we will have opportunities to address additional high value applications in the global insulation market and in a diverse set of new markets, including the electric vehicle market.

We have grown our business by forming technical and commercial relationships with industry leaders, which has allowed us to optimize our products to meet the particular demands of targeted market sectors. We have benefited from our technical and commercial relationships with ExxonMobil in the oil refinery and petrochemical sector, with TechnipFMC in the offshore oil sector and with BASF in the building materials market. We will continue our strategy of working with innovative companies to target and penetrate additional market opportunities.

Our patented aerogel product and manufacturing technologies are significant assets. Aerogels are complex structures in which 97% of the volume consists of air trapped between intertwined clusters of amorphous silica solids. These extremely low density solids provide superior insulating properties. Although aerogels are usually fragile materials, we have developed innovative and proprietary manufacturing processes that enable us to produce industrially robust aerogel insulation cost-effectively and at commercial scale.

Our products help customers to improve the resource efficiency and sustainability of their operations. Our products enable compact system design, reduce installation time and costs, promote freight and logistics cost savings, reduce system weight and required storage space and enhance job site safety. Our products reduce the incidence of corrosion under insulation, which is a significant maintenance cost and safety issue in energy infrastructure facilities. Many of our products also offer strong fire protection, which is a critical performance requirement in our markets. We believe our array of product attributes provides strong competitive advantages over traditional insulation. Although competing insulation materials may have one or more comparable attributes, we believe that no single insulation material currently available offers all of the properties of our aerogel insulation products.

Total revenue for the years ended December 31, 2019, 2018 and 2017 was $139.4 million, $104.4 million and $111.6 million, respectively. For the years ended December 31, 2019, 2018 and 2017, based on shipment destination or research services location, our

U.S. revenue was $58.3 million, $41.7 million and $51.4 million, respectively, and our international revenue was $81.0 million, $62.6 million and $60.2 million, respectively.

We manufacture our products using proprietary and patent-protected technology at our facility in East Providence, Rhode Island. We have operated the East Providence facility since 2008 and have significantly increased our manufacturing capacity and productivity since that date. We commenced operation of our third production line in the East Providence facility in 2015 which increased our annual nameplate capacity to 50 million square feet of aerogel blankets. In 2018, we initiated a series of projects designed to increase this nameplate capacity by 20 percent to 60 million square feet of aerogel blankets by the end of 2020. As of December 31, 2019, we had increased the nameplate capacity in our East Providence facility to 55 million square feet of aerogel blankets.

Financial information about our product and research services revenues, net loss per share and our total assets are provided in our consolidated financial statements included elsewhere in this Annual Report on Form 10-K.

Our Markets and Competition

Our core market is the energy infrastructure insulation market. This market is global, well-established and includes large and well-capitalized end-users. This market includes companies operating refinery, petrochemical, oil production, and LNG production and storage facilities. The market also includes firms operating gas, coal, nuclear, hydro and solar thermal power generating plants and district energy systems. Insulation systems in the energy infrastructure market are designed to maintain hot and cold process equipment, piping and storage tanks at optimal temperatures, to protect plant and equipment from the elements and from the risk of fire, and to protect workers. The market is served by a well-organized, well-established, worldwide network of distributors, contractors and engineers.

Demand for insulation in the energy infrastructure market is composed of demand associated with new-build construction of facilities, capital expansions and related capital projects, as well as with routine, non-discretionary maintenance programs within existing facilities. Capital expansions and related capital projects in the energy infrastructure market are driven primarily by overall economic growth and projected growth in energy demand. Maintenance programs are essential to optimal operation of process equipment, to protect workers and to minimize the risk of a catastrophic loss. Accordingly, we believe that demand for insulation for maintenance purposes in comparison to capital projects is less affected by volatility associated with economic cycles, energy prices and other macroeconomic factors.

The major end-use markets that drive demand for our products include oil refining, petrochemical, natural gas and LNG production and storage, onshore oil production, offshore oil production and power generation. Global energy demand is expected to increase in the long-term and, in order to serve this growing demand, we believe our end-use customers will continue to invest in major energy infrastructure projects.

We also sell our products for use in the building materials and other end markets, including for the fabrication of insulation parts by original equipment manufacturers, or OEMs. These OEMs develop products incorporating our aerogel blankets for applications as diverse as military and commercial aircraft, trains, buses, appliances, apparel, footwear and outdoor gear. While these are not presently our core markets, we anticipate that we will allocate a growing portion of our manufacturing capacity to serve these markets in the long term. We believe the key performance criteria for insulation in these markets and applications include thermal performance, compact design, durability and fire resistance.

We operate in a highly competitive environment. In general, we compete with traditional insulation materials based on product performance, price, availability and proximity to the customer. Customers may choose among a variety of insulation materials that offer a range of characteristics including thermal performance, durability, vapor permeability, moisture resistance, ease of installation and upfront and lifecycle costs. Within each type of insulation material, there is also competition between the manufacturers of that material. Most types of traditional insulation materials are produced by a number of different manufacturers and once customers have chosen the type of insulation material that they intend to use, they will choose a manufacturer of that material based primarily on each manufacturer's price and delivery schedule. Insulation manufacturers include a range of large, high-volume, multinational manufacturers offering branded products and strong technical support services to small, low-volume, local manufacturers offering low prices and limited customer support.

We believe the primary competitive factors in our market are:

- product performance (along multiple criteria), quality and fitness for purpose;
- product price, installed cost and lifecycle cost;
- product availability; and
- proximity to customer and logistics.

Our products are priced at a premium to traditional insulation materials. While our competitors offer many traditional insulation products that are priced below our products on a per-unit basis, we believe our products have superior performance attributes and may have the lowest cost on a fully-installed basis or offer significant life-cycle cost savings.

We compete in the aerogel insulation market with Cabot Corporation, Armacell International S.A., Guangdong Alison Hi-Tech Co., Ltd. and Nano Tech Co., Ltd. and a growing number of other competitors that manufacture, sell or resell aerogel insulation products. We expect to face increasing competition in the aerogel insulation market over the next several years as existing competitors and new entrants seek to develop and market their own aerogel products. In addition to other aerogel insulation products, we also encounter competition from innovatively packaged traditional insulation materials that compete with our products on the basis of one or more performance factors.

Within each of our target markets, we encounter one or more of these organizations or their resellers and a significant number of other aggressive national, regional and local suppliers of traditional insulation products. Our competitors are seeking to enhance traditional insulation materials and to develop and introduce new and emerging insulation technologies. Competing technologies that outperform our insulation products in one or more performance attributes could be developed and successfully introduced. See "Risk Factors —The energy infrastructure insulation market is highly competitive; if we are unable to compete successfully, we may not be able to increase or maintain our market share and revenues."

Our market share in 2019 was approximately 4% of the estimated $3.1 billion annual global market for energy infrastructure insulation materials. Many of our competitors have greater market presence, larger market share, longer operating histories, stronger name recognition, larger customer bases and significantly greater financial, technical, sales and marketing, manufacturing and other resources than we have and may be better able to withstand volatility within the industry and throughout the economy as a whole while retaining greater operating and financial flexibility. If our competitors lower their prices, or develop new products with better performance, or if we are unable to compete effectively, our growth opportunities, share of the market, margins and profitability may decline.

Our Competitive Strengths

Because insulation is used in a wide variety of demanding applications, insulation materials must satisfy a wide range of performance criteria on a cost-effective basis. We believe that our aerogel technology has allowed us to create superior insulation products for our core markets that will allow us to continue to grow our share of the global insulation market. We believe that the potential for significant technological innovation in traditional insulation materials is limited and that new high-performance materials will be required to meet evolving market requirements for energy efficient insulation systems. Our line of high-performance aerogel blankets is positioned to meet these requirements. Our solution is driven by our innovative and proprietary technology that produces aerogels in a flexible and industrially robust blanket form and is supported by over 20 years of research and development dedicated to new aerogel compositions, form factors and manufacturing technologies. We believe our aerogel blankets deliver a superior combination of performance attributes that enable end-users to save money, improve resource efficiency, preserve operating assets and protect workers across a wide range of applications in our target markets.

We believe the following combination of capabilities distinguishes us from our competitors and positions us to continue to gain market share in the energy infrastructure insulation market:

- ***Disruptive Products with a Compelling Value Proposition.*** Our aerogel products provide two to five times the thermal performance of widely used traditional insulation in a thin, easy-to-use and durable blanket form. We believe our array of product attributes provides strong competitive advantages over traditional insulation and will enable us to gain a larger share of the energy infrastructure insulation market. Although competing insulation materials may have one or more comparable attributes, we believe that no single insulation material currently available offers all of the properties of our aerogel insulation.
- ***Important Energy End Markets.*** Our products are primarily used in large scale energy infrastructure facilities. Given continued growth in global energy consumption in the long-term, and the construction of new facilities to satisfy this

demand, we believe that we serve well capitalized and growing global end markets. In order to capture the opportunities in our end markets, we have a network of sales professionals and qualified distributors in more than 50 countries around the world.

- ***Growing Installed Base with Industry-leading End-Users.*** We have an installed base of more than 354 million square feet of insulation, representing more than $958 million in cumulative product sales since 2008. Through our relationships with industry leading end-use customers, our products have undergone rigorous testing and technical validation and are now in use at most of the world's largest oil producers, refiners and petrochemical companies. These relationships have shortened the sales cycle with other customers and have helped to facilitate our market penetration. We also have strong relationships with a global network of energy-focused distributors, contractors and engineering firms that understand the significant advantages our products provide to end-users.
- ***Proven, Scalable Business Model.*** Our proprietary manufacturing technology is proven and has been successfully scaled up to meet increasing demand. We have operated the East Providence facility since 2008 and have significantly increased manufacturing capacity and productivity during the period. We successfully commenced operation of our second production line at this facility in March 2011 and doubled our annual nameplate capacity to 40 million square feet of aerogel blankets. We commenced operations of a third line in the East Providence facility during the first quarter of 2015 which increased our annual nameplate capacity by 25% to 50 million square feet of aerogel blankets. During 2018, we initiated a series of projects, which we refer to as EP20, designed to increase this nameplate capacity to 60 million square feet of aerogel blankets by the end of 2020. As of December 31, 2019, we had increased the nameplate capacity in our East Providence facility to 55 million square feet of aerogel blankets.
- ***Protected Technology Platform and Proprietary Manufacturing Capability.*** Our aerogel technology platform is the result of more than 20 years of research and development dedicated to new aerogel compositions, form factors and manufacturing technologies. Our intellectual property portfolio is supported by 145 issued patents, with an additional 96 pending, in U.S. and foreign jurisdictions in areas related to product design, chemistry, process technology and market applications. In addition, we have significant know-how and trade secrets related to product formulations and manufacturing techniques. We believe our portfolio of patents, trade secrets and know-how presents a barrier to potential new entrants in the commercialization of aerogel blanket insulation.
- ***Experienced Management Team with a Demonstrated Track Record.*** Our executive officers have an average of more than 20 years each of experience in global industrial companies, specialty chemical companies or related material science research. This management team is responsible for the continued development of our aerogel technology platform, the commercial acceptance of our products, and the creation of a global distribution and marketing platform. As of December 31, 2019, we employed 303 people including material scientists, engineers, manufacturing line operators, sales personnel, administrative staff, and management. We believe our dedicated and experienced team is an important competitive asset.

Our Growth Strategy

Our strategy is to create economic value by leveraging our technological and market leadership in aerogels to be the premier provider of high-performance insulation products serving global energy infrastructure customers. We also will pursue high-value opportunities for our aerogel products within other segments of the global insulation market, including the building materials market. In addition, we will leverage our aerogel technology platform to develop innovative, aerogel enhanced products for applications outside the global insulation market.

Key elements of our strategy include:

- ***Broaden Energy Market Diversity and Grow Market Share.*** We plan to add resources to continue to grow our share of the energy infrastructure insulation market, both through increased sales to our existing customers and through sales to new customers. We plan to continue to expand and enhance our global sales and distribution network and seek to promote greater enterprise-wide adoption of our products by existing end-use customers. To date, the majority of our revenue has been generated from applications in refineries and petrochemical facilities. We will continue to pursue and expect greater adoption of our products for applications in the LNG and power markets. In addition, our product revenue will continue to be generated, in large part, by demand for insulation associated with scheduled plant shutdowns, or turnarounds, and other maintenance-related projects. With broad adoption of our products and our growing installed base, we expect that our products will be specified at increasing rates during the design phase in a growing number of new-build and capital expansion projects. We also expect that growth in global energy demand over time will result in increased new-build and large capacity expansion projects; thereby driving additional demand for our aerogel products.

- ***Leverage Strategic Relationships in the Building Materials Market.*** We are pursuing market opportunities across multiple regions to address the increasingly stringent regulatory environment governing the thermal performance of buildings. We have entered into a multi-faceted strategic partnership with BASF to develop and commercialize products optimized for the building materials market. The strategic partnership offers a near-term commercial opportunity through the sale of our Spaceloft A2 product line and long-term commercial potential through our joint development efforts focused on innovative products and technologies that address emerging opportunities. We believe our strategic partnership with BASF will facilitate our penetration of the building materials market by combining the strength of our aerogel technology platform with BASF's broad technical, commercial and distribution capabilities.

- ***Capitalize on Innovation to Develop New Markets.*** Our team of materials scientists and engineers focus on advancing our aerogel technology platform and developing next generation aerogel compositions, form factors and manufacturing processes. We believe that we are well positioned to leverage over 20 years of research and development to develop and commercialize disruptive aerogel products for a wide array of new markets beyond energy infrastructure and building materials. We will seek to exploit the unique characteristics of aerogels, including low thermal conductivity, high surface area, high electrical conductivity, and tunable porosity, to develop aerogel enhanced products and next generation technology addressing complex and unmet market needs. We will continue to seek potential partnerships with industry leaders that include a mix of commercial, technical and financial elements to realize the full potential offered by our proprietary aerogel technology platform in targeted markets.

- ***Leverage Aerogel Technology Platform in the Electric Vehicle Market.*** Aligned with our strategy to capitalize on innovation, we launched our battery materials program during 2019 to seek to leverage the unique properties of our proprietary and patented carbon aerogels to improve the performance and cost of lithium-ion batteries. We have entered into evaluation agreements with third parties to initially explore the potential use of Aspen's silicon-rich carbon aerogel materials in the anode of lithium-ion batteries. In concert with our partners, we are seeking to focus our technical development and accelerate the potential commercialization of these carbon aerogel anode materials in the electric vehicle market. In addition, in response to inquiries from several electric vehicle manufacturers, we are seeking to optimize our traditional silica aerogel blankets for potential use in lithium-ion battery systems to inhibit the spread of thermal runaway related fires. We will continue to seek to engage with additional leading battery material and electric vehicle manufacturers to realize the full potential of our aerogel technology platform within the electric vehicle market.

- ***Strategically Increase Capacity to Meet Demand.*** Demand for our aerogel products has grown significantly since our inception. From 2008 through 2019, our product revenue has grown at a compound annual growth rate of 21% to $136.9 million. To meet growth in demand for our products, we added a third production line in our East Providence facility in 2015 which increased our annual nameplate capacity to 50 million square feet of aerogel blankets. We have initiated a series of projects, which we refer to as EP20, designed to increase the nameplate capacity of the East Providence facility by an additional 10 million square feet of aerogel blankets by the end of 2020 at a projected cumulative cost of less than $5 million. As of December 31, 2019, we had increased the nameplate capacity in our East Providence facility to 55 million square feet of aerogel blankets and believe we are on track to achieve our EP20 goals by the end of 2020.

- ***Enhance Our Profit Margins, Operational Cash Flow and Return on Invested Capital.*** We will seek to continuously improve the cost efficiency of our manufacturing process, to optimize the formulation of our products and to manage our supply chain to reduce costs. We believe additional opportunities to realize production efficiencies and to reduce per unit overhead costs will arise with growth in the scale of our manufacturing operations. We believe our current expansion plans and available manufacturing technology advancements will enhance profit potential, increase operating cash flow capability, and offer attractive returns on incremental invested capital. In addition, we will focus our development efforts on new products and next generation technology with application in new, high value market segments.

Our Products

Silica aerogels are highly porous structures in which 97% of the volume consists of air trapped between intertwined clusters of amorphous silica solids. Silica aerogels are a very low density solids and are extremely fragile materials. However, our proprietary manufacturing process produces silica aerogels in a flexible, resilient, durable and easy-to-use blanket form.

The core raw material in the production of our aerogel insulation products is silica precursors. Our manufacturing process initially creates a semi-solid alcogel in which the silica structure is filled with ethanol. We produce aerogel by means of a supercritical extraction process that removes ethanol from the gel and replaces it with air. Our process allows the ethanol to be extracted without causing the solid matrix in the gel to collapse from capillary forces.

Our material costs were 48%, 47% and 45% of product revenue for the years ended December 31, 2019, 2018 and 2017, respectively. We seek to lower our manufacturing costs, while maintaining appropriate performance characteristics, and to improve the per square foot costs of our silica aerogel blankets by optimizing our formulations to reduce material costs, by enhancing manufacturing process controls to improve yields, by realizing price reductions from existing vendors, by qualifying new vendors and by reducing shipping costs. Our objective is both to reduce costs to enhance our competitive position and to ensure we deliver high quality products to our customers.

The materials used in the production of our products consist primarily of several silica precursors, fiber batting, and other additives. The markets for these materials are generally competitive and multiple sources of supply exist for all of our raw materials. However, during 2018, we experienced a significant increase in the price of certain silica precursors due to a supply imbalance in the silanes market. We are actively working to reformulate our products to reduce our reliance on the materials that are susceptible to significant price fluctuations. We are also working to expand the geographic diversity of our supply base to reduce the risk of demand and supply imbalances in any one country or region.

We purchase silica precursors from several suppliers in the United States, Europe and Asia, including China. Based on the current level of demand for our products, we believe that an adequate long-term supply of silica precursors is available. However, if demand for our products increases rapidly, we will need to work with suppliers to ensure that an adequate long-term supply of silica precursors will be available at competitive prices. Suppliers of silica precursors include industrial companies that produce the materials directly or that produce them as a byproduct of other industrial processes. We are working with a number of these suppliers to plan for our potential future needs and to develop our processes to reduce the long-term cost impact of these materials. See "Risk Factors — Shortages of the raw materials used in the production of our products, increases in the cost of such materials or disruptions in our supply chain could adversely impact our financial condition and results of operations."

Our aerogel blankets are reinforced with fiber batting. We manufacture and sell our blankets in 60 inch wide, three foot diameter rolls with a standard range of thickness of 5 millimeters to 10 millimeters. Our base products are all flexible, hydrophobic, vapor permeable, compression resistant and able to be cut and fabricated using conventional tools. We have specifically developed our line of aerogel blankets to meet the requirements of a broad set of applications within our target markets. The composition and attributes of our standard aerogel blankets are described below:

Energy Infrastructure Markets

- ***Pyrogel XTE.*** Pyrogel XTE, our best-selling product, is reinforced with a glass-fiber batting and has an upper use temperature of 650° C. Pyrogel XTE was initially designed for use in refineries and petrochemical facilities, but has proven to have wide applicability throughout the energy infrastructure market. Pyrogel XTE is optimized for high temperature applications between 100° C and 400° C. Pyrogel XTE's hydrophobicity and vapor permeability reduce the risk of corrosion under insulation in energy infrastructure operating systems when compared to traditional insulation.
- ***Pyrogel HPS.*** Pyrogel HPS is optimized for applications within the power generation market with operating temperatures greater than 400° C. With an upper use temperature of 650° C, high durability and extremely low thermal conductivity, Pyrogel HPS is ideal for installation in high performance turbine systems and in demanding thermal environments in power plants and systems. Pyrogel HPS also provides strong value at high temperatures and in demanding thermal applications in refining and chemical processing systems.
- ***Pyrogel XTF.*** Pyrogel XTF provides thermal performance similar to Pyrogel XT, but is reinforced with a glass- and silica-fiber batting. Pyrogel XTF is specially formulated to provide strong protection against fire.
- ***Cryogel Z.*** Cryogel Z is designed for sub-ambient and cryogenic applications in the energy infrastructure market. Cryogel Z is reinforced with a glass- and polyester-fiber batting and is produced with an integral vapor barrier. Cryogel Z is also

specially formulated to minimize the incidence of stress corrosion cracking in stainless steel systems. Cryogel Z's combination of properties allow for simplified system designs and reduced installation costs in cold applications throughout the energy infrastructure market when compared to traditional insulation.

- ***Spaceloft Subsea.*** Spaceloft Subsea is reinforced with glass- and polyester-fiber batting and is designed for use in pipe-in-pipe applications in offshore oil production. Spaceloft Subsea is typically fabricated and pre-packaged to permit faster installation. Spaceloft Subsea allows for small profile carrier pipelines and associated reductions in capital costs.

Other Markets

- ***Spaceloft Grey.*** Spaceloft Grey is reinforced with a glass- and polyester- fiber batting and is designed for use in the building materials market. Spaceloft Grey is either utilized in roll form by contractors in the field or fabricated by OEMs into strips, panels and systems that meet industry standards. Spaceloft Grey is designed for use in solid wall buildings and where space is at a premium.
- **Spaceloft A2**. Spaceloft A2 is reinforced with a glass-fiber batting and specifically designed to meet Euroclass A2 fire standards in the building materials market. Spaceloft A2 is marketed and sold exclusively by our partner BASF SE under the SLENTEX® brand. Spaceloft A2 is designed to provide industry-leading thermal performance in applications where building regulations require the use of non-combustible products.
- ***Cryogel X201.*** Cryogel X201 is similar in composition to Cryogel Z, but is produced without the integral vapor barrier. Cryogel X201 is designed for use in cold system designs where space is at a premium. Cryogel X201 is targeted to OEMs that design, produce and sell refrigerated appliances, cold storage equipment and aerospace systems.

R-Values by Material

Insulation is a material or combination of materials that slows the transfer of heat from one side of the material to the other. The composition of our aerogel products minimizes the three mechanisms of thermal transport:

- ***Conduction.*** Heat conduction through a material is correlated to the material's density. Aerogels are very low density solids. As a result, thermal conductivity through the aerogel material itself is extremely low.
- ***Convection.*** Heat convection in gases is through movement of gas molecules. Due to the restricted movement of gases in the aerogel structure, thermal convection is eliminated inside the aerogels.
- ***Radiation.*** Radiation requires no medium to transfer the heat. Thermal radiation is partially absorbed by aerogels. Our aerogel products also contain infrared absorbing additives to significantly reduce radiant heat transfer.

We believe our aerogel products offer the lowest levels of thermal conductivity, or best insulating performance, of any widely used insulation available on the market today.

The lower a material's thermal conductivity, the more slowly heat is transferred through the material. R-values are a commonly used measure of an insulating material's resistance to heat transfer. R-value is calculated as the thickness of an insulation material divided by the thermal conductivity of the insulation material. Materials with higher R-values have lower thermal conductivity and are better insulators. Traditional and specialty insulation materials provide a range of R-values. Aerogels have the highest R-value per unit of thickness in comparison to traditional insulation materials.

Qualification for Use

Our products have undergone rigorous testing and are now qualified for global usage in both routine maintenance and in capital projects at many of the world's largest oil producers, refiners and petrochemical companies. These end-users of our products have well defined practices, codes, specifications and standards for materials and systems installed or used in their facilities. These specifications include insulation system design standards, material qualification and selection processes, and insulation application practices. As part of the material qualification process established by these companies, a new insulation product must meet general industry standards, such as consensus standards developed by ASTM International, and, in some cases, company-specific internal standards to be considered for use. In addition, most of these companies require one or more field trials to evaluate fitness for use in specific applications. These companies either run these qualification processes and field trials internally or through third parties engaged by them, and they generally do not publicly disclose the results of their testing. While the specific processes and timelines vary from company to company, in general, upon successful completion of the qualification process for an insulation product, an end-user will typically deem the product to be qualified for use in its facilities on a local, regional or global basis for one or more applications. Because our end-use customers are typically businesses with very large operations in multiple sites, our insulation sales likely represent only a small portion of the total insulation used by any one of these companies. Accordingly, once our products are qualified at a company, we continue to seek to expand use of our products by the end-use customer in additional applications and at multiple locations.

Our Sales Channel

We market and sell our products primarily through our global sales force. Our sales personnel are based in North America, Europe and Asia and travel extensively to market and sell our products to new and existing customers. The efforts of our sales force are supported by a small number of sales consultants with extensive knowledge of a particular market or region. Our sales force establishes and maintains customer and partner relationships, delivers highly technical information and provides first class customer service. We plan to expand our sales force globally to support anticipated growth in customers and demand for our products.

Our sales force calls on and maintains relationships with participants at all levels of the insulation industry supply chain. We have established a network of insulation distributors to ensure rapid delivery of our products in critical regions. Our sales personnel work to educate insulation contractors about the technical and operating cost advantages of aerogel blankets. Our sales force also works directly with end-users and engineering firms to promote qualification, specification and wider acceptance of our products in existing and new applications. In the energy infrastructure market, we rely heavily on the existing and well-established channel of distributors and contractors to deliver products to our customers. In addition, our sales personnel work with OEMs and strategic partners to create new products and solutions to expand our market reach.

The sales cycle for a new insulation material is typically lengthy. Our sales cycle from initial customer trials to widespread use can take from one to three years, although we typically realize increasing revenue at each stage in the cycle. We believe our relationships with technically sophisticated customers and strategic partners serve to validate our technology, products and value proposition within a target market. These relationships have proven to accelerate the sales cycle with other customers within specific markets and to facilitate growth in market share. We have focused our marketing efforts on developing technical support materials, installation guides, case studies and general awareness of the superior performance of our aerogel blankets. We rely principally on our website, social media, printed technical materials, participation in industry conferences and tradeshows and presentation of technical papers to communicate our message to existing and potential customers. We also receive strong word-of-mouth support from the growing network of distributors, installation contractors, OEMs, strategic partners and end-users that understand the benefits of our products.

As of December 31, 2019, we had 47 sales and marketing professionals worldwide. Their efforts were supported by a team of eleven sales consultants.

Our Customers and End-Users

Customers

Our primary customers are distributors, installation contractors and OEMs that stock, install and fabricate insulation products, components and systems for technically sophisticated end-users that require high-performance insulation.

- ***Distributors:*** We currently operate through a global network of 68 insulation distributors. In general, insulation distributors stock, sell and distribute aerogel materials to insulation contractors and end-users. The distribution of our product outside the United States is at times conducted under agreements that provide for exclusivity by geography linked to annual purchase volume minimums. These insulation distributors typically market, promote and advertise our aerogel materials across their market.
- ***Contractors:*** We currently sell directly to a number of insulation contractors under project specific contracts or general purchase orders. Insulation contractors generally perform insulation installation, inspection, maintenance and project management for end-users. In addition, some insulation contractors provide end-users with project engineering and design services.
- ***OEMs:*** We currently sell directly to a small network of OEMs that design, fabricate and manufacture insulation components and systems for use in the energy infrastructure, industrial, building materials, transportation, appliance and apparel markets.
- ***Direct Sales to End-Users:*** In certain instances, we sell directly to end-use customers in the energy infrastructure insulation market. In these instances, our end-use customer directly manages and controls specification, logistic, installation, inspection, maintenance and fabrication activities of our aerogel products.

Distribution International, Inc. and SPCC Joint Venture represented 20% and 13%, respectively, of our total revenue in 2019 and were our only customers representing 10% or more of our revenue for that period.

Our product revenue is generated by sales to customers around the world. In 2019, 41% of our product revenue was generated in the United States, 32% in Asia, 18% in Europe, 7% in Canada and 2% in Latin America based on shipment destination.

A substantial portion of our sales are to shipment destinations located outside the United States, including Thailand, Norway, Canada, Great Britain, Singapore, Korea, Hong Kong, Australia, Egypt, and Taiwan. Total revenue generated from outside of the United States amounted to $81.0 million or 58% of total revenue, $62.6 million or 60% of total revenue and $60.2 million or 54% of total revenue, in the years ended December 31, 2019, 2018 and 2017, respectively. In addition, we may continue to expand our operations outside the United States. As a result, we are subject to a number of risks. See "Risk Factors — A substantial portion of our revenue comes from sales in foreign countries and we may expand our operations outside of the United States, which subjects us to increased economic, foreign exchange, operational and political risks that could increase our costs and make it difficult for us to operate profitably."

End-Users

The end-users of our aerogel blankets include some of the largest and most well capitalized companies in the world. Our products are installed in more than 50 countries worldwide.

Energy Infrastructure

- ***Oil Refining:*** We believe our products have been installed in more than 30% of the world's 640 refineries. In addition, we believe our aerogel blankets are used by 24 of the world's 25 largest refining companies including ExxonMobil, Shell and Chevron, among others. Over time, these companies have used our products in an increasing range of applications and throughout an increasing number of their facilities.
- ***Petrochemical:*** We believe our aerogel blankets are used by all of the world's 20 largest petrochemical companies including Reliance Industries, Formosa Petrochemical, and LyondellBasell Industries, among others.
- ***Natural Gas and LNG:*** Our products are in use at facilities operated by PTT LNG, ExxonMobil, and Dominion Energy, among others.
- ***Onshore:*** Our aerogel blankets are in use in several Canadian oil sands facilities owned and operated by Suncor Energy, ConocoPhillips and Husky Energy, among others.
- ***Offshore:*** Our products are currently used in subsea projects off the coast of Brazil, in the Gulf of Mexico, in the North Sea, off the coast of Malaysia and off the west coast of Africa. Our products are installed in offshore projects owned by Total, Marathon Oil, ConocoPhillips and Shell, among others.
- ***Power Generation:*** We are targeting operators of gas, coal, nuclear, hydro and solar power generating facilities. Our products are currently used at facilities owned and operated by NextEra Energy Resources, Southern Company and Duke Energy, among others.
- ***District Energy:*** Our products are used in medium- to high – temperature steam distribution networks in universities and municipalities within the United States and Asia.

Building Materials and Other Markets

Traditionally, we have relied on the efforts of a small network of partners, OEMs and fabrication houses to serve the building materials, transportation, apparel and appliance markets. These partners, OEMs and fabricators are manufacturers of components and systems for buildings, refrigerated and hot appliances, cold storage equipment, automobiles, aircraft, trains and electronic sectors and manufacturers of outdoor gear and apparel. In addition, we have partnered with BASF to develop and commercialize innovative products optimized to meet the needs of the building materials market. The end-users of our products in these markets include a wide range of institutions, businesses, individuals, municipalities and government agencies.

Manufacturing

We manufacture our products using our proprietary technology at our facility located in East Providence, Rhode Island. We have operated the East Providence facility since 2008 and have significantly increased manufacturing capacity and productivity during the period. Our manufacturing process is proven, scalable and can meet increasing demand.

Our manufacturing group is led by a seasoned team with management experience at global industrial and specialty chemical companies. Our manufacturing workforce is skilled and, to date, we have experienced employee turnover consistent with our industry. We have well-defined operating processes and maintenance, environmental, health and safety programs to support our operations. We employ statistical processes and quality controls in our manufacturing systems. We measure and monitor thermal conductivity, hydrophobicity and other key properties of our aerogel blankets in our manufacturing operations. We are ISO 9001:2015 certified.

We successfully commenced operation of our third production line at the East Providence facility in 2015, which increased our annual nameplate capacity to 50 million square feet of aerogel blankets. We have initiated a series of projects, which we refer to as EP20, designed to increase the nameplate capacity of the East Providence facility by an additional 10 million square feet of aerogel blankets by the end of 2020. As of December 31, 2019, we had increased the nameplate capacity in our East Providence facility to 55 million square feet of aerogel blankets and believe we are on track to achieve our EP20 goals by the end of 2020. The EP20 projects are designed to improve manufacturing productivity and capital efficiency through a phased deployment of enhanced chemical and process technologies. We may incur additional capital expenditures during 2020 to complete this plan.

We directly control all stages in the manufacture of our aerogel blankets. Our direct ownership of manufacturing operations allows us to maintain control of proprietary process technologies and to control product quality. Our production of aerogel blankets utilizes a continuous process and consists of the following key steps:

- ***Sol Preparation.*** Mixing of silica precursors in ethanol, a catalyst and additives in set formulas to deliver the target properties of the resultant aerogel.
- ***Casting.*** Combination of the sol and fiber batting and initial formation of the gel structure.
- ***Aging.*** Bathing of the gel blankets in fluids to impart desired physical and thermal properties.
- ***Extraction.*** Supercritical extraction of the ethanol liquid from the gel blanket to produce a dried aerogel blanket.
- ***Heat Treatment.*** Drying to remove trace ethanol, salts and water from the aerogel blankets.
- ***Finishing.*** Coating to enhance quality and product handling.
- ***Quality Control.*** Utilizing statistical process and quality controls to measure thermal conductivity, hydrophobicity and other key properties of our aerogel blankets.

Our material costs were 48%, 47% and 45% of product revenue for the years ended December 31, 2019, 2018 and 2017, respectively.

The materials used in the production of our products consist primarily of a several silica precursors, fiber batting, and other additives. The markets for these materials are generally competitive and multiple sources of supply exist for all of our raw materials. However, during 2018, we experienced a significant increase in the price of certain silica precursors due to a supply imbalance in the silanes market. We are actively working to reformulate our products to reduce our reliance on materials that are susceptible to significant price fluctuations. We are also working to expand the geographic diversity of our supply base to reduce the risk of demand and supply imbalances in any one country or region.

We purchase silica precursors from several suppliers in the United States, Europe and Asia, including China. Based on the current level of demand for our products, we believe that an adequate long-term supply of silica precursors is available. However, if demand for our products increases rapidly, we will need to work with suppliers to ensure that the long-term supply of silica precursors will be available at competitive prices. Suppliers of silica precursors include industrial companies that produce the materials directly or that produce them as a byproduct of other industrial processes. We are working with a number of suppliers to plan for our potential future needs and to develop our processes to reduce the long-term cost impact of these materials. See “Risk Factors — Risks Related to Our Business and Strategy — Shortages of the raw materials used in the production of our products, increases in the cost of such materials or disruptions in our supply chain could adversely impact our financial condition and results of operations.”

We seek to lower our manufacturing costs, while maintaining appropriate performance characteristics, and to improve the per square foot costs of our aerogel blankets by optimizing our formulations to reduce material costs, by enhancing manufacturing process controls to improve yields, by realizing price reductions from existing vendors, by qualifying new vendors and by reducing shipping costs. In addition, we believe additional opportunities to realize production efficiencies and to reduce per unit overhead costs will arise with growth in the scale of our manufacturing operations. Our objective is both to reduce costs to enhance our competitive advantage and to ensure we deliver high quality finished products to our customers.

Research and Development

The mission of our research and development team is to leverage our aerogel technology platform in support of our commercial objectives. In our existing markets, research and development personnel design new and improved insulation products to enhance our value to customers and to expand our revenue potential. Our materials scientists and engineers also seek to develop enhanced chemical and process technologies to improve yields, lower manufacturing costs and improve product performance. In new markets, research and development personnel seek to exploit the unique characteristics of aerogels, including low thermal conductivity, high surface area, high electrical conductivity, and tunable porosity, to develop aerogel enhanced products and next generation technology addressing complex and unmet market needs.

Our research and development expenditures were $8.4 million, $6.3 million and $6.2 million for the years ended December 31, 2019, 2018 and 2017, respectively. In addition, we spent $1.3 million, $1.0 million and $0.9 million for the years ended December 31, 2019, 2018 and 2017, respectively, on research and development activities sponsored by federal and other government agencies.

Contract Research and Government Support

We regularly seek funding from a number of federal and other government agencies in support of our research and development and manufacturing activities. Research performed under contract to the Department of Defense, the Department of Energy and other institutions allows us to develop and leverage technologies into broader commercial applications. We also work closely with customers in government and industry to develop potential aerogel solutions that leverage not only the thermal insulation performance but other benefits of aerogels as well. The research and development activities that we conduct under such contracts may produce intellectual property to which we may not have ownership or exclusive rights and will be unable to protect or monetize.

Under our contracts, the U.S. government generally has the right not to exercise options to extend or expand our contracts and may modify, curtail or terminate the contracts at its convenience. Our government customers may not renew our existing contracts after the conclusion of their terms and we may not be able to enter into new contracts with U.S. government agencies. Any decision by the U.S. government not to exercise contract options or to modify, curtail or terminate our contracts or not to renew our contracts or enter into new contracts with us would adversely affect our revenues.

In late 2019, we decided to cease efforts to secure additional funded research contracts and to wind down our existing contract research activities during 2020. This decision reflected our desire to focus our research and development resources on initiatives to improve the profitability of our existing business and on efforts to develop new products and next generation technology with application in new, high value market segments.

We have received $58.3 million in funding under government contracts from inception through December 31, 2019. Our contract research revenue was $2.4 million, $2.2 million and $2.0 million for the fiscal years ended December 31, 2019, 2018 and 2017, respectively.

Intellectual Property

Our success depends in part upon our ability to obtain, maintain and enforce intellectual property rights that cover our aerogel technology platform, including, product forms, applications and/or manufacturing technologies and the technology or know-how that enables these product forms, applications, technologies and specifications, to avoid and defend against claims that we infringe the intellectual property rights of others, and to prevent the unauthorized use of our intellectual property. Since aerogels were developed more than 80 years ago, there has been a wide range of research, development and publication on aerogels and related technologies, which make it difficult to establish intellectual property rights to many key elements of aerogel technology and to obtain meaningful patent protection. Where appropriate, we seek to protect our rights by filing patent applications in United States and other key foreign jurisdictions related to products, processes, technology and improvements that we consider patentable and important to our business and, in particular, our aerogel technology, product forms and their applications in promising markets and our manufacturing technologies. We also rely on trade secrets, trademarks, licensing agreements, confidentiality and nondisclosure agreements and continuing technological innovation to safeguard our intellectual property rights and develop and maintain our competitive edge.

As of December 31, 2019, we owned 47 issued U.S. patents, 21 pending U.S. patent applications (including five issued U.S. patents and one pending U.S. patent application that we co-own with third parties), 98 issued foreign patents and 75 pending foreign patent applications (including 19 issued foreign patents and 14 pending foreign patent applications that we co-own with third parties). The patents that we own are generally effective for 20 years from the filing date of the earliest application to which each U.S. patent claims priority. The scope of each of our foreign patents varies in accordance with local law. Our early product patents start to expire in December 2021.

In May 2016, we filed a complaint for patent infringement against Nano Tech Co., Ltd. (Nano), and Guangdong Alison Hi Tech., Ltd. (Alison) in the International Trade Commission, or ITC. In the ITC complaint, we alleged that these two China-based companies have engaged and are engaging in unfair trade practices by importing aerogel products in the United States that infringe, and/or are manufactured by processes that infringe, several of our patents in violation of Section 337 of the Tariff Act of 1930. In the ITC complaint, we sought exclusion orders from the ITC that direct the United States Customs and Border Protection to stop the importation of these infringing products. In February 2018, the ITC issued its final determination confirming the Administrative Law Judge's (ALJ) previous initial determination that Nano and Alison had infringed asserted Aspen patents and that they have not proven the patents are invalid except with respect to one dependent product claim, which the ITC found was not infringed. The ITC affirmed that Alison and Nano each violated Section 337 of the Tariff Act and issued a limited exclusion order prohibiting importation of infringing aerogel insulation products manufactured by Alison and Nano. Alison unsuccessfully appealed the ITC determination with respect to a product patent to the United States Court of Appeals for the Federal Circuit (CAFC), which affirmed the validity of Aspen's patent. The exclusion order, which is enforced by the United States Customs and Border Protection, is currently in effect. Additionally, the United States Patent and Trademark Office, or USPTO, denied Alison's requests to invalidate the claims of four of Aspen's patents in Inter-Partes Review. Alison also filed multiple similar requests with the Chinese Patent Office, or SIPO, seeking to invalidate our Chinese manufacturing process patents and two of our Chinese product patents. With respect to one of those requests, not withdrawn previously by Alison, the Patent Reexamination Board of SIPO (PRB), issued a decision upholding the validity of Aspen's issued patent as amended in the proceedings. Alison has appealed the PRB's decision to the Beijing IP court. After the oral hearing at the Beijing IP court, we are awaiting the decision by the court. Nano has also filed a request seeking invalidation of a product patent at PRB of SIPO on which the oral hearing took place in July 2019. After the oral hearing, Nano withdrew its invalidation request. On September 23, 2019, Alison filed yet another request to invalidate the same patent, whose prior validity opinion by PRB is currently on appeal at the Beijing IP Court. After conducting an oral hearing, PRB issued a decision on January 23, 2020 denying Alison's latest invalidation request of this patent.

In April 2016, we also filed a patent infringement suit at the District Court in Mannheim, Germany (Mannheim court), against Nano, Alison and two European resellers asserting their infringement of one of our German patents. We subsequently asserted infringement of another three patents against Nano, Alison and a European reseller of Alison's products at the Mannheim court. We have since settled with one European reseller in exchange for a commitment not to procure infringing products and cooperation with our case. In January 2018, the court issued a series of judgments by acknowledgement (German, "Anerkenntnisurteil") finding the second reseller, Hiltex, liable for infringement and also issued injunctions against Hiltex. The judgments resulted from a settlement agreement in which Hiltex agreed not to resell the infringing products in Europe where at least one of the asserted patents are active. Nano and Alison also initiated nullity actions in German Federal Patent Court in Munich against our asserted German patents.

On March 8, 2019, Mannheim court issued two separate judgments in cases against Nano and Alison. The Mannheim court determined that both Nano and Alison are infringing on Aspen's EP1638750 (750 Patent) in connection with their respective products. The court also issued injunctions prohibiting the offer, putting on the market, using, importing or possessing the infringing products. The court found the defendants liable to us for damages since September 22, 2012. The court also ordered the defendants to provide information on the scope of the acts of infringement committed since August 22, 2012, and a recall of infringing products. The court also ordered Nano and Alison to bear the costs of the legal proceedings and reimburse statutory attorneys' costs and expenses to us, that exact amount of which is yet to be determined. Nano and Alison have appealed the judgements of the Mannheim court. The appeal is currently ongoing. The Federal Patent Court in Munich previously dismissed the challenge to the validity of 750 Patent which has become final.

Nano and Alison also filed an opposition to one of the asserted patents at the European Patent Office (EPO). In December 2018, the opposition division of EPO determined the patent, EP2813338 (338 Patent) was invalid on formality grounds and decided to revoke it, which determination is currently under appeal at the EPO Board of appeals. On March 19 and 20, 2019 the German Federal Patent Court in Munich conducted oral proceedings and voided four claims in EP2415577 (577 Patent) and confirmed the validity of challenged claims in EP2422950 (950 Patent) within the scope of silica gels. The Mannheim court issued two judgments on December 23, 2019 finding that Alison infringed 577 Patent and 950 Patent and also issued injunctions prohibiting Alison from continuing infringement in connection with any aerogel sheets. As of March 6, 2020, we are unaware of any timely appeal of these December 2019 decisions by Alison. Upon confirmation of the same by the Mannheim Court, we expect the decisions to become final. The infringement proceedings at the Mannheim court based on 577 Patent and 950 Patent are currently ongoing against Nano.

Additionally, a reseller of Nano's products in Taiwan challenged the validity of one of our patents in Taiwan in 2018. After careful review of our written response, the Taiwanese patent office has determined the patent as valid and dismissed the challenge in December 2018. In 2018, LG Chem Ltd. challenged the validity of one of our patents in Korea at the Intellectual Property Trial and Appeals Board (IPTAB) of the Korean Intellectual Property Office. After conducting an oral hearing, the IPTAB issued a decision on November 30, 2019 upholding claims related to aerogel sheets incorporating fibers and invalidating claims for aerogel sheets not incorporating fibers. The IPTAB decision is currently on appeal at the Korean Patent Court.

Due to their nature, it is difficult to predict the outcome or the costs involved in any litigation. Furthermore, our adversaries may have significant resources and interest to litigate and therefore, these litigation matters could be protracted and may ultimately involve significant legal expenses. We have incurred approximately $9.0 million of expenses related to this litigation since 2015 through December 31, 2019. In addition to the foregoing, we have been and may be from time to time party to other legal proceedings that arise in the ordinary course of business and to other patent enforcement actions to assert our patent rights.

We believe that having distinctive names is an important factor in marketing our products, and therefore we use trademarks to brand some of our products, including Pyrogel, Cryogel and Spaceloft. As of December 31, 2019, we had five trademark registrations in the United States, one trademark registration with the World Intellectual Property Organization, and 52 trademark registrations in foreign jurisdictions, including the European Union, Japan, China, Canada, South Korea and Brazil. Additionally, we had eight pending foreign trademark applications. Although we have a foreign trademark registration program for selected marks, our approach may not be comprehensive and we may not be able to register or use such marks in each foreign country in which we seek registration.

Cross License Agreement with Cabot Corporation

In April 2006, we entered into a cross license agreement with Cabot Corporation, as amended in September 2007, in which each party granted certain intellectual property rights to the other party. The cross license agreement remains in effect until the expiration of the last to expire of the issued patents or patent applications and acquired patents licensed thereunder. We hold a non-exclusive, worldwide license to those patents and patent applications owned or licensed by Cabot that are necessary for us to (i) practice our manufacturing technology within a field of use, which is defined in accordance with the specific chemistry of our aerogel products and the supercritical fluid technology that we use in our manufacturing technology and (ii) use and sell the resulting aerogel blanket and derivative products. We paid Cabot $38 million over a period of approximately seven years, with the last payment made in March 2013, in connection with this license agreement. We have granted to Cabot a reciprocal, non-exclusive, worldwide license to certain patents and patent applications that we own that are necessary for Cabot to practice its processes within a field of use defined in accordance with the specific chemistry in its aerogel products and the drying technology that it uses to manufacture its products. The grant of license to each party covers issued patents, patent applications and patents issued from such counterpart applications, as well as patents licensed or acquired during a specified period, in each case that claim aerogels, or methods, materials of manufacture, or uses of aerogels.

Our Company

We are a corporation organized under the laws of Delaware. In June 2008, we completed a reorganization pursuant to which our predecessor company merged with and into a newly formed Delaware corporation, renamed Aspen Aerogels, Inc. We own three wholly owned subsidiaries: Aspen Aerogels Rhode Island, LLC, Aspen Aerogels Germany, GmbH and Aspen Aerogels Georgia, LLC, which was formed in August 2016. We maintain our corporate offices in Northborough, Massachusetts.

On June 18, 2014, we completed our initial public offering, or IPO, of 7,500,000 shares of our common stock at a public offering price of $11.00 per share. On February 18, 2020, we completed an underwritten public offering of 1,955,000 shares of our common stock at a public offering price of $8.25 per share. As of March 5, 2020, we had 26,594,455 shares of our common stock outstanding.

We are required to file annual, quarterly and current reports, proxy statements and other information required by the Securities Exchange Act of 1934, as amended, or the Exchange Act, with the Securities and Exchange Commission, or the SEC. SEC filings are available at the SEC's website at https://www.sec.gov.

We maintain a public website at https://www.aerogel.com and use our website as a means of disclosing material non-public information and for complying with our disclosure obligations under Regulation FD. Our website includes an Investors section through which we make available, free of charge, our Annual Reports on Form 10-K, Quarterly Reports on Form 10-Q, Current Reports on Form 8-K, Proxy Statements and Forms 3, 4 and 5 filed on behalf of directors and executive officers, as well as any amendments to those reports filed or furnished pursuant to the Exchange Act as soon as reasonably practicable after we electronically file such material with, or furnish it to, the SEC. The members of our Board of Directors and the designated chairs of the committees of the Board of Directors are reflected on the signature page of this annual report on Form 10-K. We also make available on our website the charters for our Board of Directors' Audit Committee, Compensation and Leadership Development Committee and Nominating and Corporate Governance Committee, as well as our Code of Business Conduct and Ethics, our Corporate Governance Guidelines and other related materials. The information on our website is not part of this annual report.

Our Investor Relations Department can be contacted at Aspen Aerogels, Inc., 30 Forbes Road, Building B, Northborough, MA 01532, Attention: Investor Relations; telephone: 508-691-1111; e-mail: ir@aerogel.com.

Employees

As of December 31, 2019, we had 303 full-time employees and one part-time employee, with 36 in research and development, 195 in manufacturing operations and supply chain, 47 in sales and marketing and 25 in general and administrative functions. Of our employees, 289 are located in the United States and 14 are located abroad. We consider our current relationship with our employees to be of good standing. None of our employees are represented by labor unions or have collective bargaining agreements.

Seasonality

Our industry and product offering makes us less susceptible to seasonal patterns as our operating results are generated in part by demand for insulation associated with new-build construction of facilities, capital expansions and related capital projects, and larger maintenance-related projects in the energy infrastructure market. Historically, our third and fourth quarter results have shown increased levels of revenue, which we believe is associated with our end-use customers' maintenance schedules and timing of capital projects.

Environmental Matters

We are subject to federal, state, local and foreign laws and regulations designed to protect the environment and to regulate the discharge of materials into the environment. We believe that our policies, practices, and procedures are properly designed to prevent unreasonable risk of environmental damage and associated financial liability. To date, environmental control regulations have not had a significant adverse effect on our overall operations. See "Risk Factors — We may incur significant costs complying with environmental, health and safety laws and related claims, and failure to comply with these laws and regulations could expose us to significant liabilities, which could adversely affect our results of operations."

Item 1A. RISK FACTORS

Risks Related to Our Business and Strategy

We have incurred annual net losses since our inception, and we may continue to incur net losses in the future and may never reach profitability.

We have a history of losses, and we may not ever achieve full year profitability. We experienced net losses of $14.6 million, $34.4 million and $19.3 million for the years ended December 31, 2019, 2018 and 2017, respectively. As of December 31, 2019, our accumulated deficit was $486.2 million. We expect to continue to incur operating losses as a result of expenses associated with the continued development and expansion of our business. Our expenses include research and development, sales and marketing, and general and administrative costs. Furthermore, these expenses are not the only factors that may contribute to our net losses. For example, interest expense that we incur on any future financing arrangements could contribute to our net losses. Any failure to increase revenue or manage our cost structure as we implement initiatives to grow our business could prevent us from achieving profitability, or sustaining profitability if we do achieve it. In addition, our ability to achieve profitability is subject to a number of risks and uncertainties discussed below, many of which are beyond our control. Failure to become and remain profitable may adversely affect the market price of our common stock and our ability to raise capital and continue operations.

We have yet to achieve positive total cash flow, and our ability to generate positive cash flow is uncertain.

To develop and expand our business, we have made significant up-front investments in our manufacturing capacity and incurred research and development, sales and marketing and general and administrative expenses. In addition, our growth has required a significant investment in working capital. We experienced negative cash flows from operating activities of $1.1 million, $8.7 million and $4.6 million for the years ended December 31, 2019, 2018 and 2017, respectively. The negative cumulative cash flows from operating activities during the three year period were exacerbated by cash flows used in investing activities to maintain, enhance and expand our manufacturing operations during the same time period. As a result, we experienced negative total cash flows during the three year period.

We expect our total cash flow will be positive on an annual basis during 2020. However, we expect to experience significant variability in the levels of working capital required to support our operating activities from time to time. As a result, we project that our existing cash balance alone may periodically be insufficient to fund these working capital requirements during the year. During such periods, we would be dependent on our line of credit with Silicon Valley Bank, or SVB, under which we have the ability to borrow up to $20.0 million, to fund the balance of the required investment in working capital. The credit agreement requires us to comply with both non-financial and financial covenants, which have included minimum Adjusted EBITDA and during previous renewal periods, minimum Adjusted Quick Ratio covenants, as defined in the credit agreement. In May 2018, August 2018, November 2018 and December 2018, we obtained waivers from SVB related to our compliance with these financial covenants. These waivers were subject to certain conditions, including, in the case of the November 2018 waiver, the Company's issuance of $3.25 million in equity or receipt of $5.0 million in customer advanced payments on or before January 31, 2019. Although we met these conditions, including in connection with the November 2018 waiver upon receipt on January 30, 2019 of a $5.0 million advanced payment from BASF, there can be no assurance that we will continue to comply with such covenants or that SVB will waive such potential or actual non-compliances, if requested, or waive them with reasonable and achievable conditions. As a result, we could end up in default under the agreement or otherwise be unable to continue to borrow under our line of credit, subject to acceleration of the payment of any balance and further subject to the remedies typically available to a lender. See "*Our revolving credit facility contains financial and operating restrictions that may limit our access to credit. In addition, our revolving credit facility expires on April 28, 2021 and we may not be able to renew, extend or replace the expiring facility. If we fail to comply with covenants in our revolving credit facility or if facility is terminated, we may be required to repay our indebtedness thereunder, which may have an adverse effect on our liquidity*."

In addition, we may not achieve sufficient revenue growth to generate positive cash flow in 2020 or beyond. Furthermore, the amounts available under our line of credit with SVB may be insufficient to fund periodic working capital requirements during the year. As a result, we may need to raise additional capital from investors to achieve our expected growth or to fund the working capital investment necessary to maintain operations. Any inability to generate positive future cash flow, to borrow funds or to raise additional capital on reasonable terms, if at all, may harm our short-term financial condition or threaten our long-term viability.

Our working capital requirements involve estimates based on demand and production expectations and may decrease or increase beyond those currently anticipated, which could materially harm our results of operations and financial condition.

In order to fulfill the product delivery requirements of our direct and end-use customers, we plan for working capital needs in advance of customer orders. As a result, we base our funding and inventory decisions on estimates of future demand. If demand for our products does not increase as quickly as we have estimated or drops off sharply, our inventory and expenses could rise, and our business and results of operations could suffer. Alternatively, if we experience sales in excess of our estimates, which has materialized in previous reporting periods, our working capital needs may be higher than those currently anticipated. Our ability to meet this excess customer demand depends on our ability to arrange for additional financing for any ongoing working capital shortages, since it is likely that cash flow from sales will lag behind these investment requirements. In the past, we have principally relied on our line of credit with SVB to supplement these financing needs. The revolving credit agreement requires us to comply with both non-financial and financial covenants. During 2018, we failed on three occasions to comply with a single liquidity related financial covenant, but we were able to obtain waivers on all three occasions from SVB with respect to our compliance with this covenant and ultimately, comply with the conditions of the waivers. In the future, there can be no assurance that we will continue to comply with such covenants and that SVB will waive such non-compliance, if requested. As a result, we could end up in default under the agreement or otherwise be unable to continue to borrow under our line of credit. Any failure to borrow under our line credit when needed could adversely affect our ability to invest in the working capital required to maintain and grow our business.

Our revolving credit facility contains financial and operating restrictions that may limit our access to credit. In addition, our revolving credit facility expires on April 28, 2021 and we may not be able to renew, extend or replace the expiring facility. If we fail to comply with covenants in our revolving credit facility or if facility is terminated, we may be required to repay our indebtedness thereunder, which may have an adverse effect on our liquidity.

Provisions governing our revolving credit facility impose restrictions on our ability to operate, including, for some of the agreements and instruments, but not for others, our ability to:

- incur capital expenditures;
- incur additional debt;

- pay dividends and make distributions;
- redeem or repurchase capital stock;
- create liens;
- enter into transactions with affiliates; and
- merge or consolidate with or into other entities.

Our revolving credit facility also contains other financial and non-financial covenants. We may not be able to comply with these covenants in the future. Our failure to comply with these covenants may result in the declaration of an event of default and could cause us to be unable to borrow funds under our revolving credit facility. In addition to preventing additional borrowings under our revolving credit facility, an event of default, if not cured or waived, may result in the acceleration of the maturity of indebtedness outstanding under the revolving credit facility, which would require us to pay all amounts outstanding. Such an event may also lead our lender to exercise its security interest in our assets, including all of our real property and equipment at our East Providence facility. If an event of default occurs, we may not be able to cure it within any applicable cure period, if at all. If the maturity of our indebtedness is accelerated, we may not have sufficient funds available for repayment or we may not have the ability to borrow or obtain sufficient funds to replace the accelerated indebtedness on terms acceptable to us, or at all.

We will require significant additional capital to pursue our growth strategy, but we may not be able to obtain additional financing on acceptable terms or at all.

The growth of our business will depend on substantial amounts of additional capital for expansion of existing production lines or construction of new production lines or facilities, for ongoing operating expenses, for continued development of our aerogel technology platform, or for introduction of new product lines. Our capital requirements will depend on many factors, including the rate of our revenue growth, our introduction of new products and technologies, our enhancements to existing products and technologies, and our expansion of sales and marketing and product development activities. In particular, our plans to potentially expand capacity beyond our existing facility in East Providence, Rhode Island are dependent on our ability to raise debt and issue equity. There is no assurance that we will be able obtain any such type of financing on terms acceptable to us or at all and in a timely manner.

In addition, we may consider strategic acquisitions of complementary businesses or technologies to grow our business, which would require significant capital and could increase our capital requirements related to future operation of the acquired business or technology.

We may not be able to obtain loans or raise additional capital on acceptable terms or at all. Our revolving credit facility with SVB contains restrictions on our ability to incur additional indebtedness, which, if not waived, could prevent us from obtaining needed capital. In addition, our revolving credit facility is scheduled to mature on April 28, 2021. Any future credit facilities or debt instruments would likely contain similar or additional restrictions, requirements or conditions. We may not be able to obtain bank credit arrangements or effect an equity or debt financing on terms acceptable to us or at all in order to fund our future capacity expansion plans. Any failure to obtain additional financing when needed could adversely affect our ability to maintain and grow our business.

Shortages of the raw materials used in the production of our products, increases in the cost of such materials or disruptions in our supply chain could have a material adverse impact on our financial condition and results of operations.

The raw materials used in the production of our products consist primarily of fiber battings, silica precursors and other additives. In addition, the production process requires the use of process gases and other materials typical to the chemical processing industry, as well as access to electricity, natural gas, water and other basic utilities. Although we are not dependent on a single supplier, we are dependent on the ability of our third-party suppliers to supply such materials on a timely and consistent basis. While these materials and utilities are available from numerous sources, they may be, and have been in the past, subject to fluctuations in availability and price. For example, during the year ended December 31, 2018, we experienced a significant increase in the costs of silica precursor materials, constituting over 50% of our raw material costs, which has continued through the year ended December 31, 2019.

Our third-party suppliers may not dedicate sufficient resources to meet our scheduled delivery requirements or our suppliers may not have sufficient resources to satisfy our requirements during any period of sustained or growing demand. Failure of suppliers to supply, delays in supplying or disruptions in the supply chain for our raw materials, or adverse allocations in the supply of certain high demand raw materials could materially adversely affect the results of our operations. Supply disruptions may affect our ability to meet our delivery schedules on a timely basis and materially negatively impact our results of operations. For example, in September 2015, pursuant to a force majeure notification, our primary carbon dioxide gas supplier temporarily curtailed supply of carbon dioxide to us due to a feedstock issue impacting the northeastern United States. During this period, the supply disruption required that we intermittently idle a portion of our manufacturing equipment thereby reducing our production volume and adversely impacting our results of operation.

Most of our raw materials are procured through individual purchase orders or short-term contracts and not through long-term contracts that ensure a fixed price or guaranteed supply for an extended period of time. This procurement strategy may not support sustained long-term supply chain stability. Fluctuations in the prices of these raw materials could have a material adverse effect on our results of operations. Our suppliers also seek alternative uses for our raw materials at higher price points. Such competitive uses for our raw materials creates material price and availability risks to our business. In addition, our ability to pass increases in raw material prices on to our customers is limited due to competitive pricing pressure and the time lag between the increase in costs and the implementation of related price increases.

In particular, we purchase a variety of silica precursors from several suppliers, mostly pursuant to individual purchase orders or short-term contracts and not pursuant to long-term contracts. We do not have a secure, long-term supply of silica precursors. We may not be able to establish arrangements for secure, long-term silica precursor supplies at prices consistent with our current costs or may incur a delay in supply while we seek alternative sources. For example, we experienced a significant increase in the price of certain silica precursors during 2018 due to a supply imbalance in the silanes market. While we seek to reformulate our products to reduce our reliance on materials that are susceptible to significant price fluctuations, while maintaining appropriate performance characteristics, our efforts may not be successful. Any inability to continue to purchase silica precursors without long-term agreements in place, or to otherwise establish a long-term supply of silica precursors at prices consistent with our current cost estimates, would have a material adverse effect on our ability to increase our sales and achieve profitability.

Additionally, our suppliers may prioritize their resources for any long-term commitments to third parties and to our detriment. We may not be in a position to find alternate suppliers in a timely manner to continue to operate consistent with our obligations to or expectations of our customers. The supply chain for our materials has been increasingly global in nature. The global events like trade wars between nations or corona virus outbreak could have both short-term and long-term effects on our supply chain.

Pandemics involving corona viruses, such as the COVID-19, could have an adverse impact on our supply chain, reduce the demand for our products or otherwise negatively affect our financial performance.

From time to time, diseases such as SARS, MERS, avian flu and other corona viruses have spread across the world, resulting in substantial health and economic harm to the affected population. If a disease such as the recently identified corona virus, COVID-19, spreads sufficiently to cause a pandemic (or to cause the fear of a pandemic to rise), governments around the world may start regulating or restricting the flow of labor, travel and transport of materials. Such restrictions could severely affect our suppliers, employees, customers and distributors. The adverse effects of such events on us may include a significant disruption to our supply chain, our operations, or demand for our products in the short and/or long term. As a result, we might be unable to sustain operations for an extended period of time and our business, our results of operations and our financial position would be materially adversely affected, potentially threatening our viability.

We are dependent on a single manufacturing facility. Any significant disruption to this facility or the failure of any one of our three production lines in this facility to operate according to our expectation could have a material adverse effect on our business and results of operations.

We have three production lines in a single manufacturing facility located in East Providence, Rhode Island. Our ability to meet the demands of our customers depends on efficient, proper and uninterrupted operations at this manufacturing facility. In the event of a significant disruption to our sole manufacturing facility or breakdown of any of the production lines, we currently do not expect that we would have sufficient inventory in stock to meet demand until the production lines return to operation.

Power failures or disruptions, the breakdown, failure or substandard performance of equipment, or the damage or destruction of buildings and other facilities due to fire or natural disasters could severely affect our ability to continue our operations. In the event of such disruptions, we are unlikely to find suitable alternatives or may not be able to make needed repairs on a timely basis and at reasonable cost, which could have a material adverse effect on our business and results of operations. In particular, our manufacturing processes include the use of high pressures, high temperatures and flammable chemicals, which subjects us to a significant risk of loss resulting from fire, spill or related event. We had occasional incidences of fires at our initial facility in Northborough, Massachusetts that preceded our current manufacturing facility in East Providence, Rhode Island.

If our manufacturing facility or any equipment therein were to be damaged or cease operations, it may reduce revenue, cause us to lose customers and otherwise adversely affect our business. The insurance policies we maintain to cover losses caused by fire or natural disaster, including business interruption insurance, may not adequately compensate us for any such losses and will not address a loss of customers that we expect would result or may have large deductibles insufficient to support our continuing operations. If our existing manufacturing facility was damaged or destroyed, we would be unable to operate our business for an extended period of time and our business and results of operations may be materially adversely affected, potentially even threatening our viability.

From time to time we have had difficulty in consistently producing products that meet applicable product specifications and technical and delivery requirements, and such difficulties could expose us to financial, contractual or other liabilities.

Our insulation products are technologically advanced and require a precise and complex manufacturing process. Because of the precision and complexity of this manufacturing process and the high-performance characteristics of our products, from time to time we have had difficulty in consistently producing products that meet applicable specifications and technical and delivery requirements, including, our customers' and the end-users' specifications and requirements. At certain times in the past, the growth in demand for our products has contributed to this difficulty by putting significant pressure on our management, our personnel and our production facilities. See "Risk Factors — Growth has placed significant demands on our management systems and our infrastructure. If we fail to manage our long-term growth effectively, we may be unable to execute our business plan, address competitive challenges and meet applicable product specifications and technical and delivery requirements."

Furthermore, we seek to lower our manufacturing costs, while maintaining appropriate performance characteristics, and to improve the per square foot costs of our silica aerogel blankets by optimizing our formulations to reduce material costs. Any failure to meet the specifications for our products as a result of our attempts to optimize our formulations, or otherwise, or technical and delivery requirements could result in the termination of existing customer contracts or purchase orders, the elimination or reduction of future purchase orders, the impairment of customer relationships, and the incurrence of financial, contractual or other liabilities. Products that do not meet these specifications or requirements may also expose us to warranty and product liability claims and associated adverse publicity. Any such termination, reduction, impairment, liability or publicity could result in a broader loss of existing customers and revenues and delay the execution of our business plans, disrupt our operations and could have a material adverse effect on our results of operations and financial condition.

A sustained downturn in the energy industry, due to lower oil and gas prices or reduced energy demand, could decrease demand for some or all of our products and services, which could have a material adverse effect on our business, financial condition and results of operations.

Demand for a significant portion of our products and services depends on the level of capital expenditure by companies in the energy industry, which depends, in part, on current and expected energy prices. Prices of oil and gas have been highly volatile in the past several years with oil prices reaching a high above $100 per barrel in mid-2014 to a low below $30 per barrel in early 2016. The volatility in oil prices and declines in oil prices, which are often associated with unrelated world events, have resulted, from time to time, in a reduction in capital expenditures by many companies in the energy industry, and in particular by end-users of our products involved in the construction and expansion of offshore and onshore oil and gas production facilities. Sustained lower energy prices may also reduce our end-users' need to improve energy savings by using premium-priced insulation products like ours, thus reducing demand for our products and causing downward pressure on the pricing of our products. A sustained downturn in the capital expenditures of our customers, whether due to periods of lower energy prices or a further decrease in the market price of oil and gas or otherwise, and including the perception that such a downturn might occur or continue, may delay capital projects, decrease demand for our products and cause downward pressure on the prices we charge for our products, which, in turn, could have a material adverse effect on our business, financial condition and results of operations. Such downturns, including the perception that they might occur or continue, could have a significant negative impact on the market price of our common stock.

Regulation of greenhouse gas emissions could reduce demand for hydrocarbon products and lead to a sustained downturn in the energy industry, which could decrease demand for our products and have a material adverse effect on our business, financial condition and results of operation.

Due to growing concerns about the risks of climate change, a number of countries are adopting or considering adopting regulations to reduce greenhouse gas emissions. Greenhouse gas regulations could have the impact of increasing energy costs, reducing the demand for hydrocarbons, decreasing profitability and return on investment in the energy industry, and leading to a sustained downturn in the energy industry. Demand for a significant portion of our products depends on the aggregate level of capital expenditure in the energy industry, which depends, in part, on the expected return on such investments. A sustained period of diminished returns or expected returns on capital deployed in the energy industry as a result of greenhouse gas regulations or otherwise, may delay capital projects, decrease demand for our products and cause downward pressure on the prices we charge for our products, which, in turn, could have a material adverse effect on our business, financial condition, results of operations and the market price of our common stock.

The markets we serve are subject to general economic conditions and cyclical demand, which could harm our business and lead to significant shifts in our results of operations from quarter to quarter that make it difficult to project long-term performance.

Our results of operations have been, and may in the future be, adversely affected by general economic conditions and the cyclical pattern of certain industries in which our customers and end-users operate. Demand for our products and services depends in large part upon the level of capital and maintenance expenditures by many of our customers and end-users, in particular those in the energy, petrochemical and power generation industries, and firms that design, construct and operate facilities for these industries.

These customers' expenditures historically have been cyclical in nature and vulnerable to economic downturns. In particular, profitability in the energy industry is highly sensitive to supply and demand cycles and commodity prices, which historically have been volatile; and our customers in this industry historically have tended to delay large capital projects, including expensive maintenance and upgrades, during industry downturns. Delays in customer projects may cause fluctuations in the timing or the amount of revenue earned and our results of operations in a particular period. Prolonged periods of little or no economic growth could decrease demand for oil and gas which, in turn, could result in lower demand for our products and a negative impact on our results of operations and cash flows. This risk increases as we seek to increase the project based revenue as a percentage of the total revenue. In addition, this cyclical demand and potential customer project delays may lead to significant shifts in our results of operations from quarter to quarter and from year to year, which limits our ability to make accurate long-term predictions about our future performance. We estimate that sales to end-use customers in the energy industry accounted for approximately 97% of our 2019 revenues and we expect that they will continue to account for a significant portion of our future revenues.

The market for insulation products incorporating aerogel blankets is relatively undeveloped and our products may never be widely adopted, which would have a material adverse effect on our business.

The market for insulation products utilizing aerogel blankets is relatively undeveloped. Accordingly, our future results of operations will depend in large part on our ability to gain market share of the global energy infrastructure insulation market. Our ability to gain market share in this market is highly dependent on the acceptance of our products by large, well-established end-users, distributors, contractors and OEMs. The insulation market has historically been slow to adopt new technologies and products. Most insulation types currently in use in these markets were developed over 50 years ago. In addition, there is a tendency of end-users in some of our markets to opt for the lower short-term costs associated with traditional insulation materials. If we fail to successfully educate existing and potential end-users, distributors, contractors and OEMs of the benefits and value offered by our aerogel products, or if existing users of our products no longer rely on aerogel insulation for their insulation needs, our ability to sell our products and grow our revenue could be limited.

Our business strategy also includes the development of next generation products with the performance characteristics and price points required by markets outside the energy infrastructure and building materials markets, including the electric vehicle market. These performance and price requirements can be more demanding than those we faced in energy infrastructure and building materials markets. In the event that we are unable to develop products that meet market needs, we may be unable to successfully penetrate such markets. In addition, the innovative product and manufacturing methods development process requires the dedication of significant human, technical and financial resources, with no certainty of success or recovery of our related investment. As a result, we may be unable to grow our business in markets outside of the energy infrastructure and building materials markets, which could adversely affect our financial performance.

Because we are often a new supplier with new type of materials, to our end-use customers, we also may face concerns from these end-use customers about our reliability and our ability to produce our products in a volume sufficient to meet their supply and quality control needs. As a result, we may experience a reluctance or unwillingness by existing end-use customers to expand their use of our products and by potential end-use customers to begin using our products. Our products may never reach mass adoption, and changes or advances in technologies could adversely affect the demand for our products.

A failure to increase, or a decrease in, demand for aerogel insulation products caused by lack of end-user, market or distribution channel acceptance, technological challenges or competing technologies and products would result in a lower revenue growth rate or decreased revenue, either of which could have a material adverse effect on our business and our results of operations.

Our products are expensive relative to other insulation products, which could make it more difficult for us to grow our revenue and achieve broader adoption of our aerogel products.

While we believe our products have superior performance attributes and may sometimes have the lowest cost on a fully-installed basis or offer life-cycle cost savings, our competitors offer many traditional insulation products that are priced below our products. Our products are expensive relative to alternative insulation products and end-use customers may not value our products' performance attributes sufficiently to pay their premium price. This could make it more difficult for us to grow our revenue and achieve broader adoption of our aerogel products. While we seek to lower our manufacturing costs, while maintaining appropriate performance characteristics, and to improve the per square foot costs of our silica aerogel blankets by optimizing our formulations to reduce material costs, we may not be successful in doing so. In addition, some of the benefits of our products are based on reduced installation time and related labor expense. In regions where labor costs are significantly lower than in the United States and Europe, the cost benefits of reduced installation times may not be adequate to overcome the relatively high price of our products and may make it more difficult for us to grow our revenue in those regions.

The insulation market we serve is highly competitive. If we are unable to compete successfully, we may not be able to increase or maintain our market share and revenues.

We face strong competition primarily from established manufacturers of traditional insulation materials. Large producers of traditional insulation materials, such as Johns Mansville, Saint-Gobain, Knauf Gips, Owens Corning and Rockwool, dominate the insulation market. In addition, we face increasing competition from other companies seeking to develop high-performance insulation materials, including aerogel insulation. For example, Cabot Corporation manufactures, markets and sells a different form of aerogel insulation that is competitive with our products, particularly in the offshore oil and gas sector for use in pipe-in-pipe applications. We are also aware of competitors including Armacell International S.A., Guangdong Alison Hi-Tech Co, Ltd, Nano Tech Co, Ltd, and other Asia-based companies which manufacture and/or market aerogel insulation products in blanket form. Many of our competitors are substantially larger and better capitalized than we are and possess greater financial resources. Our competitors could focus their substantial financial resources to develop new or additional competing products or develop products that are more attractive to potential customers than the products that we offer. We expect to face an increasing amount of competition in the aerogel insulation market over the next several years as existing competitors and new entrants seek to develop and market their own aerogel products.

Because some insulation manufacturers are substantially larger and better capitalized than we are, they may have the ability to sell their products at substantially lower costs to a large, existing customer base. Our products are expensive relative to other insulation products and end-use customers may not value our products' superior performance attributes sufficiently to pay their premium price. In addition, from time to time we may increase the prices for our products and these price increases may not be accepted by our end-use customers and could result in a decreased demand for our products. Similarly, we may make changes to our products in order to respond to customer demand or to improve their performance attributes and these changes may not be accepted by our end-use customers and could result in a decrease in demand for our products. These competitive factors could:

- make it more difficult for us to attract and retain customers;
- cause us to slow the rate of increase of our prices, delay or cancel planned price increases, lower our prices or discount our prices in order to compete; and
- reduce our market share and revenues.

Any of these outcomes could have a material adverse effect on our results of operations, financial condition and cash flows.

Failure by us to develop, maintain and strengthen strategic relationships with industry leaders to commercialize our products in the building materials market may adversely affect our results of operations and our ability to grow our business.

Our business strategy requires us to align the design and performance attributes of our products to the evolving needs of the market. To facilitate this process, we have sought out partnerships and relationships with industry leaders in order to assist in the development and commercialization of our products. We face competition from other manufacturers of insulation in seeking out and entering into such partnerships and relationships with industry leaders in our target markets and we may therefore not be successful in establishing strategic relationships in those markets.

In the building materials market, we have entered into an amended and restated supply agreement and an amended and restated side agreement (together, the supply agreement) with BASF Polyeurathanes GmbH, or BASF, and a joint development agreement with BASF SE. Pursuant to the supply agreement, we sell exclusively to BASF certain products at annual volumes to be specified by BASF, at its full discretion, subject to certain volume limits. BASF has no obligation to purchase any products under the supply agreement. The joint development agreement is designed to facilitate the collaboration between the parties on the development and commercialization of new products, which may not result in meaningful revenue contribution to our business.

In addition to the customary terms associated with supply agreements, BASF, in its sole discretion, may make prepayments to us in the aggregate amount of up to $22.0 million during the term of the supply agreement. During 2018, BASF made prepayments to us of $5.0 million. We secured our obligation to repay the prepayment with a first priority security interest in real estate, machinery and equipment located at our existing manufacturing facility in East Providence, Rhode Island. Additionally, we granted our subsidiaries non-exclusive licenses to our intellectual property as necessary to operate this machinery and equipment.

Beginning January 1, 2019, we will credit 25.3% of any amounts that we invoice for Spaceloft A2 product sold to BASF against the outstanding balance of the 2018 prepayment. If any of the 2018 prepayment remains uncredited as of December 31, 2021, BASF may request that we repay the uncredited amount to BASF.

On January 15, 2019, we entered into an addendum to the supply agreement. The addendum provided for the inclusion of a newly developed product to be supplied to BASF under the supply agreement and for a second prepayment of $5.0 million subsequently remitted by BASF to us on January 30, 2019.

After January 1, 2020, we will credit up to 50% of any amounts that we invoice for the newly developed product sold to BASF against the outstanding balance of the 2019 prepayment. If any of the 2019 prepayment remains uncredited as of December 31, 2022, BASF may request that we either (i) credit 24.7% of any amounts we invoice for Spaceloft A2 product against the remaining balance of the 2019 prepayment, or (ii) repay the uncredited balance to BASF. The amounts and terms of additional prepayment installments, if any, are subject to further negotiation between us and BASF.

As of December 31, 2019, we had applied less than $0.1 million of credits against amounts invoiced and a substantial amount of the prepayments remain outstanding. Although BASF has placed orders for products under the supply agreement, there can be no assurance that BASF will ever be a significant customer for our products or that we deliver product quantities that would significantly reduce the prepayments outstanding by dates that which BASF has right to request repayment. Furthermore, there can be no assurance that we or BASF will be able to perform under the supply agreement or the joint development agreement or to achieve our or its respective goals with respect to the supply agreement, the joint development agreement or the broader collaboration between us and BASF. In addition, our grant of a security interest to BASF may make it more difficult for us to pledge our assets to secure other obligations, including to potential lenders, and as a result may impede our ability to incur additional indebtedness in the future.

In the event that we are unable to develop products that meet market needs or maintain our relationship with BASF, we may be required to find less prominent partners or operate without any partner at all in the building materials market and we may be less able or unable to successfully penetrate that market. As a result of any of the above, we may lessen or lose our ability to grow our business in the building materials market which could adversely affect our business, financial condition and results of operations, including impairing our profitability.

Failure by us to develop, maintain and strengthen strategic relationships with industry leaders to commercialize our products in the electric vehicle market may adversely affect our results of operations and our ability to grow our business.

Our business strategy requires us to align the design and performance attributes of our products and technologies to the evolving needs of the market. To facilitate this process, we have sought out partnerships and relationships with industry leaders in order to assist in the development and commercialization of our products. We face competition from other manufacturers of insulation, battery materials and similar products in seeking out and entering into such partnerships and relationships with industry leaders in our target markets and we may therefore not be successful in establishing strategic relationships in those markets.

In the electric vehicle market, we are seeking to engage with industry leaders to assist in the optimization of our proprietary and patented carbon aerogels to improve the performance and cost of lithium-ion batteries. We have entered into evaluation agreement with SKC Co., Ltd. to initially explore the potential use of Aspen’s silicon-rich carbon aerogel materials in the anode of lithium-ion batteries. We are also exploring various silicon materials for use with our solutions, including materials from a subsidiary of Evonik Industries AG. With the support of such third parties, we are seeking to focus our technical development and accelerate the potential commercialization of these carbon aerogel anode materials in the electric vehicle market. In addition, we are exploring with several battery and electric vehicle manufacturers to develop a highly engineered silica aerogel blanket for potential use in lithium-ion battery packs to manage the thermal runaway of the battery systems.

Unlike the other markets for which we have previously developed thermal solutions, electric vehicle market may be more demanding, technically, financially and in other ways. Additionally, the automotive industry may be more risk averse, may have longer product development and testing cycles or otherwise require resources which we cannot muster in a timely manner to successfully develop and market products and solutions.

We will continue to seek to engage with additional battery material and electric vehicle manufacturers to realize the full potential of our aerogel technology platform within the electric vehicle market. In the event that we are unable to engage with additional industry leaders or to develop products that meet market needs, we may be less able or unable to successfully penetrate that market. As a result, we may lessen or lose our ability to grow our business in the electric vehicle market which could adversely affect our business, financial condition and results of operations, including impairing our profitability.

We have entered into and may enter into future agreements that may limit our ability to broadly market our products or could involve future obligations, which could make it more difficult for us to commercialize certain of our products and negatively affect our business and results of operations.

We have a joint development agreement with BASF SE to develop products in the building materials market. In order to develop and commercialize our products, we may enter into additional joint development agreements or commercial arrangements. We cannot be certain that any products will be successfully developed under any such agreement or, even if developed, that they will be successfully produced or commercialized. These agreements may contain exclusivity, ownership of intellectual property and other terms that may limit our ability to commercialize any products or technology developed in connection with such agreements, including in ways that we do not envision at the time of entering into the agreement. In addition, these agreements may not obligate either party to make any purchases and may contain technical specifications that must be achieved to the satisfaction of our partner, which we cannot be certain we will be able to achieve. If our ability to commercialize products or technology developed in connection with these agreements is limited or if we fail to achieve the technical specifications that may be required, then our business, financial condition and results of operations could be materially adversely affected.

We may not be able to successfully develop and introduce new products in a timely manner at competitive prices, which would limit our ability to grow and maintain our competitive position and could adversely affect our financial conditions, results of operations and cash flow.

Our growth depends, primarily, on continued increase in the sales of existing products, including by improving the performance of existing products, as well as the successful development and introduction of new products, including new products for applications within the building materials and electric vehicle markets, which face the uncertainty of customer acceptance and reaction from competitors. New product development requires considerable resources and attention that may shift our focus from and may disrupt our current operations, given that we have fewer resources than many of our competitors. We may not be able to sustainably manufacture new products with attractive margins and we may experience higher production inefficiencies than expected. Any delay in the development or launch of a new product could result in our not being the first to market, which could compromise our competitive position. Even if we manage to develop and introduce new products, such products may not address market needs or otherwise compete with third party products. Even if our new products are adopted by the market, we may not achieve the growth in revenue that we expect from such new products and our investment in these efforts may not be proportional to our expected or actual revenue growth. If we are unable to develop and introduce new products in a cost-effective manner or otherwise manage effectively the operations related to new products, our results of operations and financial condition could be adversely impacted.

If we do not continue to develop and maintain distribution channels for our products and to meet our customers' demand for our products, our results of operations could be adversely affected.

For a significant portion of our revenues, we rely on sales to distributors who then sell our products to end-users in our target markets. Our success depends, in part, on our maintaining satisfactory relationships with these distributors and develop new relationships in new geographies. Our distributors require us to meet expectations of delivery, quality and pricing of our products, at both the distribution channel level and at the level of the end-user of our products. If we fail to meet expected standards, our revenues would decline and this could materially adversely affect our business, results of operations and financial condition. In addition, we have been unable at times to produce sufficient amounts of our products to meet demand from our distributors and customers and we may not be able to avoid capacity constraints in the future if demand exceeds our expectations or we fail to expand the capacity of our existing East Providence, Rhode Island manufacturing facility in a timely manner. If we are unable to deliver our products within such short timeframes, we may be at risk of losing direct or end-use customers. Accordingly, shortfalls in sales could materially adversely affect our business and results of operations.

The qualification process for our products can be lengthy and unpredictable, potentially delaying adoption of our products and causing us to incur significant expense potentially without recovery.

Qualification of our products by many of our direct and end-use customers can be lengthy and unpredictable and many of these direct and end-use customers have extended budgeting and procurement processes. This extended sales process requires the dedication of significant time by our personnel and our use of significant financial resources, with no certainty of success or recovery of our related expenses. Furthermore, even after an extensive qualification process, our products may fail to meet the standards sought by our end-use customers and may not be qualified for use by such end-use customers. Additionally, our continued process improvements and cost-reduction efforts may require us or the end-users to re-qualify our products. Failure to qualify or re-qualify our products may result in us losing such companies as end-users of our products, which would cause a decrease in our revenue or revenue growth rate either of which could materially adversely affect our business and results of operations.

Our revenue may fluctuate, which may result in a high degree of variability in our results of operations and make it difficult for us to plan based on our future outlook and to forecast our future performance.

Our revenue may fluctuate from period to period due to a wide variety of factors. Since we rely on sales to a limited number of direct customers/distributors and end-use customers, changes in demand from one or more direct customers or end-users can significantly impact our revenue from period to period. In addition, the sales cycles for our products, including their qualification for use, are long and can result in unpredictability in our revenues. We expect to have an increasing percentage of our products sold for use in capital projects, which orders tend to be larger and more sporadic, that will further increase this unpredictability and the difficulty for us in forecasting quarterly or annual performance. Because of these factors, we have a limited basis on which to predict our quarterly revenue. Our profitability from period-to-period may also vary due to the mix of products that we sell in different periods. These factors may result in a high degree of variability in our results of operations and will make it difficult for us to accurately evaluate and forecast quarterly or annual performance and to plan based on our future outlook.

The results of our operations could be materially adversely affected if our operating expenses incurred do not correspond with the timing of our revenues.

Most of our operating expenses, such as manufacturing facility expenses, employee compensation and research expenses, are either relatively fixed in the short-term or incurred in advance of sales. In addition, our spending levels are based in part on our expectations regarding future revenues. As a result, if revenues for a particular quarter are below expectations, we may not be able to proportionately reduce operating expenses for that quarter. Our reliance on sales to a limited number of direct customers/distributors and end-use customers, the length of our sales cycles and the potentially increasing percentage of our products sold for use in capital projects each can cause sporadic demand for our products which would limit our ability to predict future sales. This limitation could result in our being unable to reduce spending quickly enough to compensate for reductions in sales and could therefore adversely affect our results of operations for any particular operating period.

We are exposed to the credit risk of some of our direct customers, including distributors, contractors and OEMs, which subjects us to the risk of non-payment for our products.

We distribute our products through a network of distributors, contractors and OEMs, some of which may not be well-capitalized and may be of a lower credit quality. This direct customer network subjects us to the risk of non-payment for our products. In addition, we operate in a number of countries characterized by intermittent governmental, market and financial crises. During 2018, we established a reserve for uncollectible accounts receivable from a Brazilian contractor for $2.8 million related to a single project and wrote off another $0.1 million in accounts receivable due to non-payment of amounts due by a European customer. During 2019, we determined that collection of the remaining unpaid accounts receivable from the Brazilian contractor of $2.6 million was unlikely and recorded a write-off of the accounts receivable and the corresponding allowance for doubtful accounts. In addition, during periods of economic downturn in the global economy, our exposure to credit risks from our direct customers may increase, and our efforts to monitor and mitigate the associated risks may not be effective. In the event of additional non-payments by one or more of our direct customers, our business, financial condition and results of operations could be materially adversely affected.

If we fail to achieve the increase in production capacity that our long-term growth requires in a timely manner, or at all, our growth may be hindered and our business or results of operations may be materially adversely affected.

If, for any reason, including our inability to obtain financing, our planned expansion of capacity in our existing East Providence, Rhode Island facility should fail to be completed in a timely manner, or at all, or any of the production lines in our existing or future manufacturing facilities do not operate according to our expectations, sales and or profitability may be impeded, our growth may be hindered and our business or results of operations may be materially adversely affected.

Many factors could delay, impede or prevent the expansion of our existing manufacturing facility, or construction and operation of future, potential manufacturing facilities, or cause us to reduce the scale or scope of the expansion projects, including:

- our inability to obtain financing on favorable terms, or at all;
- design, engineering and construction difficulties or delays;
- our failure or delay in obtaining necessary legal, regulatory and other approvals and permits;
- interruptions in the supply of the necessary equipment, or construction materials or labor or an increase in their respective prices;
- opposition of local interests; and
- natural disasters, accidents, political unrest or unforeseen events, man-made or otherwise.

Many factors could prevent our existing and future, potential manufacturing facilities from producing at expected, projected or targeted nameplate capacities or could cause us to reduce the scale or scope of future capacity expansions or facilities, including:

- design and engineering failures;
- inability to retain, manage and train a skilled workforce;
- the challenges of operating technically advanced or higher volume equipment than currently employed at our existing facility in East Providence, Rhode Island;
- improper operation of the manufacturing equipment;
- decreases in our manufacturing yields due to the inefficient use of the materials needed to make our products in our manufacturing process;
- the availability of raw materials at reasonable costs to support the levels of production that we anticipate at these facilities;
- strikes or labor disputes; and
- damage to the manufacturing equipment due to design and engineering flaws, construction difficulties or operator error.

Any such capacity expansion will place a significant strain on our senior management team and our financial and other resources. The costs associated with and the resources necessary for our capacity expansion plans could exceed our expectations and result in a materially adverse impact on our business, results of operations, financial condition and cash flows.

If we are unable to complete the projects as contemplated, the costs incurred in connection with such projects may not be recoverable. For example, during 2013, we redesigned and reduced the planned scale of the third production line in our East Providence, Rhode Island facility. We recorded an associated $3.4 million impairment charge during 2013 to write off certain construction in progress assets. In addition, during 2018, we determined that our engineering plans, designs and drawings for a second manufacturing facility in Statesboro, Georgia would not be used due principally to our decision to significantly delay construction of the facility and intervening technical developments. Accordingly, we recorded an impairment charge of $7.4 million in 2018 on pre-construction and related costs for the Statesboro facility.

A redesign of, change in scale of, or failure to initiate and complete the construction of potential manufacturing facilities and other similar impairments of our assets in the future could result in a materially adverse impact on our business, results of operations, and financial condition.

If the expected growth in the demand for our products does not follow after each of our planned capacity expansions, then our business will be materially adversely affected.

Our long-term growth plan requires that we continue to increase our production capacity. As we pursue our capacity expansion plans, we will incur significant capital expenditures and increased levels of manufacturing expenses in anticipation of expected growth in demand for our products. In particular, we expect that these substantial additional expenditures will be made by us significantly in advance of the existence of the level of demand that would ensure the most efficient use of our planned new capacity. As a result, if the expected growth in demand for our products fails to materialize within a reasonable amount of time following each of our planned capacity expansions, whether because of low oil and gas prices, the loss of a significant customer, the failure to develop new markets or for any other reason, then we would suffer decreased levels of cash flow and our financial condition and results of operations would be adversely affected.

Growth has placed significant demands on our management systems and our infrastructure. If we fail to manage our long-term growth effectively, we may be unable to execute our business plan, address competitive challenges and meet applicable product specifications and technical and delivery requirements.

We may be unable to manage our growth. To manage our anticipated future growth, we must continue to:

- improve and expand our manufacturing, sales and marketing, and engineering organizations,
- enhance our research and development capabilities and resources,
- improve regulatory compliance, financial control and reporting systems;
- expand our manufacturing and distribution facilities and capacity; and
- recruit, train and retain additional qualified personnel to enhance our managerial capabilities.

All of these measures will require significant expenditures and will demand the attention of management. At certain points in the past, significant growth in demand for our products has put our management and operating systems under strain. In addition, the physical expansion of our operations may lead to significant costs and may divert our management and business development resources. Furthermore, we compete for personnel and advisors with other companies and other organizations, many of which are larger and have greater name recognition and financial and other resources than we do. Due to our limited resources, we may not be able to effectively manage the expansion of our operations or adequately recruit, train and retain qualified personnel. Any inability to manage growth could result in a loss of existing customers and revenues, delays in the execution of our business plans, and disruption of our operations. If we fail to achieve the necessary level of efficiency in our organization as it grows, it could have a material adverse impact on our business, results of operations and financial conditions.

We allocate our manufacturing operations, sales and marketing, research and development, general and administrative and financial resources based on our business plan, which includes assumptions about current and future orders and revenues from customers. However, the factors involved in such projections are uncertain. If our assumptions regarding these factors prove to be incorrect or if competing products gain further market share, then actual demand for our aerogel products could be significantly less than the demand we anticipate and we may not be able to grow our revenue or achieve profitability.

A substantial portion of our revenue comes from sales in foreign countries and we may expand our operations outside of the United States, which subjects us to increased economic, trade, foreign exchange, operational and political risks that could materially adversely impact our business, financial conditions and results of operations and also increase our costs and make it difficult for us to operate profitably.

A substantial portion of our recent sales are to destinations outside the United States, including Thailand, Norway, Canada, Great Britain, Singapore, Korea, Hong Kong, Australia, Egypt, and Taiwan. Total revenue generated from outside of the United States, based on our shipment destination, amounted to $81.0 million or 58% of total revenue, $62.6 million or 60% of total revenue and $60.2 million or 54% of total revenue, for the years ended December 31, 2019, 2018 and 2017, respectively. As a result, we are subject to a number of risks, including, but not limited to:

- the effect of applicable U.S. and foreign tax structures, including tax rates that may be higher than tax rates in the United States or taxes that may be duplicative of those imposed in the United States;
- trade relations among the United States and those foreign countries in which our customers and suppliers have operations, including protectionist measures such as tariffs and import or export licensing requirements, whether imposed by the United States or such foreign countries, in particular the strained trade relations between United States and China since 2018;
- general economic and political conditions in each country, which may interfere with, among other things, our supply chain, our customers and all of our activities in a particular location;
- difficulty in the enforcement of contractual obligations in non-U.S. jurisdictions and the collection of accounts receivable from foreign accounts;
- different regulatory regimes in the various countries in which we operate or sell our products;
- inadequate intellectual property protection in foreign countries;
- the difficulties and increased expense in complying with multiple and potentially conflicting domestic and foreign laws, regulations, product approvals and trade standards, including the U.S. Foreign Corrupt Practices Act, or FCPA, and

similar anti-bribery laws in non-U.S. jurisdictions, as well as the rules and regulations of the U.S. Department of Treasury's Office of Foreign Assets Control, or OFAC, and similar sanctions laws;

- foreign currency exchange controls, restrictions and fluctuations, which could result in reduced revenue and increased operating expense;
- transportation delays or interruptions;
- labor rules and collective bargaining arrangements in foreign jurisdictions;
- difficulty in staffing and managing (including ensuring compliance with internal policies and controls) geographically widespread operations; and
- terrorist activity and political unrest, particularly given the use of our products at energy facilities.

In addition, sales of our products are generally conducted in U.S. dollars and we also bid for foreign projects in U.S. dollars. The strengthening of the U.S. dollar against the local currencies in the countries into which we sell our products may result in our products becoming more expensive relative to competing insulation products priced in local currencies. If the U.S. dollar strengthens, our sales into foreign countries with relatively weaker currencies may be adversely impacted and we may be less competitive in bidding for projects in those markets.

Our success will depend in large part on our ability to manage the effects of continued global political and economic uncertainty, especially in our international markets.

Because of our significant international operations, we could be materially adversely affected by violations of the U.S. FCPA and similar anti-corruption, anti-bribery and anti-kickback laws.

We operate on a global basis, with 59% of our product sales in 2019 made to destinations outside the United States, including Canada, Mexico, Europe, Asia, South America and the Middle East. Our business operations and sales in countries outside the United States are subject to anti-corruption, anti-bribery and anti-kickback laws and regulations, including restrictions imposed by the FCPA, as well as the United Kingdom Bribery Act of 2010, or UK Bribery Act. The FCPA, UK Bribery Act, and similar anti-corruption, anti-bribery and anti-kickback laws in other jurisdictions generally prohibit companies, their intermediaries and their agents from making improper payments to government officials or any other persons for the purpose of obtaining or retaining business. We operate and sell our products in many parts of the world that have experienced governmental corruption to some degree and, in certain circumstances, strict compliance with anti-corruption, anti-bribery and anti-kickback laws may conflict with local customs and practices. We train our employees concerning anti-corruption, anti-bribery and anti-kickback laws and have policies in place that prohibit employees from making improper payments. We continue to implement internal controls and procedures designed to ensure that we comply with anti-corruption, anti-bribery and anti-kickback laws, rules and regulations and mitigate and protect against corruption risks. We cannot provide assurance that our internal controls and procedures will protect us from reckless, criminal or other acts committed by our employees or third-parties with whom we work. If we are found to be liable for violations of the FCPA or similar anti-corruption, anti-bribery and anti-kickback laws in international jurisdictions, either due to our own acts or out of inadvertence, or due to the acts or inadvertence of others, we could suffer criminal or civil fines or penalties or other repercussions, including reputational harm, which could have a material adverse effect on our business, results of operations and financial condition.

A failure to comply with export control or economic sanctions laws and regulations could have a material adverse impact on our business, results of operations or financial condition. We may be unable to ensure that our distributors comply with applicable sanctions and export control laws.

We operate on a global basis, with 59% of our product sales in 2019 made to destinations outside the United States, including Canada, Mexico, Europe, Asia, South America and the Middle East. We face several risks inherent in conducting business internationally, including compliance with applicable economic sanctions laws and regulations, such as laws and regulations administered by OFAC, the United States Department of State and the United States Department of Commerce. We must also comply with all applicable export control laws and regulations of the United States and other countries. Violations of these laws or regulations could result in significant additional sanctions including criminal or civil fines or penalties, more onerous compliance requirements, more extensive debarments from export privileges or loss of authorizations needed to conduct aspects of our international business.

In certain countries, we may engage third party agents or intermediaries, such as customs agents, to act on our behalf and if these third party agents or intermediaries violate applicable laws, their actions may result in criminal or civil fines or penalties or other sanctions being assessed against us. We take certain measures designed to ensure our compliance with U.S. export and economic sanctions law and we believe that we have never sold our products to Iran, Cuba, Sudan or Syria through third party agents or intermediaries or made any effort to attract business from any of these countries. However, it is possible that some of our products were sold or will be sold to distributors or other parties that, without our knowledge or consent, re-exported or will re-export such products to these countries. Although none of our non-U.S. distributors are located in, or to our knowledge, conduct business with Iran, Cuba, Sudan or Syria, we may not be successful in ensuring compliance with limitations or restrictions on business with these or other countries subject to economic sanctions. There can be no assurance that we will be in compliance with export control or economic sanctions laws and regulations in the future.

Any such violation could result in significant criminal or civil fines, penalties or other sanctions and repercussions, including reputational harm that could have a material adverse impact on our business, results of operations or financial condition.

We rely on sales to a limited number of direct customers, including distributors, contractors, OEMs, partners and end-use customers for the substantial majority of our revenue, and the loss of one or more significant direct customers or several of our smaller direct customers could materially harm our business. In addition, we understand from our direct customers that a substantial majority of their sales of our products are to a small number of end-use customers and the loss of one or more significant end-use customers or several of our smaller end-use customers could materially harm our business.

A substantial majority of our revenue is generated from sales to a limited number of direct customers, including distributors, contractors, OEMs, partners and end-use customers. For the years ended December 31, 2019, 2018 and 2017, total revenue from our top ten direct customers represented 68%, 63% and 69% of our revenues, respectively. Distribution International, Inc. and SPCC Joint Venture represented 20% and 13% of our total revenue in 2019, respectively, Distribution International, Inc. and TechnipFMC represented 15% and 12% of our total revenue in 2018, respectively; and Reliance Industries Limited and Distribution International, Inc. represented 25% and 12% of our total revenue in 2017, respectively. Although the composition of our significant distributors, contractors, OEMs, partners and end-use customers will vary from period to period, we expect that most of our revenues will continue, for the foreseeable future, to come from sales to a relatively small number of direct customers. In addition, we understand from our direct customers that a substantial majority of their sales of our products are to a small number of end-use customers.

Our direct customer concentration also creates accounts receivable concentrations and related risks. As of December 31, 2019, SPCC Joint Venture and Distribution International, Inc. accounted for 19% and 16% of our accounts receivable, respectively.

The substantial majority of our sales to distributors are transacted on a purchase order basis. The contracts we enter into with our direct customers generally do not include long-term commitments or minimum volumes that ensure future sales of our products. In addition, we understand that our direct customers' contracts with end-use customers also generally do not include such commitments or minimums. Consequently, our results of operations may fluctuate significantly from period-to-period based on the actions of one or more significant direct customers or end-use customers.

A direct customer may take actions that affect us for reasons that we cannot anticipate or control, such as reasons related to an end-use customer's financial condition, contractual arrangements with end-use customers, changes in business strategy or operations, the introduction of alternative competing products, or as the result of the perceived quality or cost-effectiveness of our products. Our agreements with these direct customers may be cancelled if we fail to meet certain product specifications or materially breach the agreement or for other reasons outside of our control. In addition, our direct customers may seek to renegotiate the terms of current agreements upon maturity or renewal. The loss of, or a reduction in sales or anticipated sales to, one or more of our significant direct customers or end-use customers or several of our smaller direct customers or end-use customers could have a material adverse effect on our business, financial condition and results of operations.

If we are unable to maintain our technological advantage over our competitors, our business may be materially adversely affected.

We research, develop, manufacture and sell high-performance aerogel insulation products. Rapid and ongoing changes in technology and product standards could quickly render our products less competitive, or even obsolete, particularly if we fail to continue to improve the performance of our insulation products. We are currently developing new applications for our existing products as well as new aerogel technologies; however, our efforts may not be successful and new applications or technologies may not be commercially useful. Other companies that are seeking to enhance traditional insulation materials have recently introduced or are developing other emerging insulation technologies. These competitors are engaged in significant development work on these various insulation products. Competing technologies that outperform our insulation in one or more performance attributes could be developed and successfully introduced.

We are also aware of certain companies, including Armacell International S.A., Guangdong Alison Hi-Tech Co, Ltd., Nano Tech Co, Ltd, and a variety of other companies based in Asia that have developed or are developing and/or marketing products using aerogel technology similar to our technology and these or other companies have introduced or could introduce aerogel products that compete directly with our products and could in the future outperform our products in one or more performance attributes, could be offered to our customers as a cheaper alternative to our products or may result in increased pricing pressure on our products. As a result of increasing competitive activity by other companies in the aerogel insulation market, both now and in the future, we may not be able to sustain our competitive position in our target markets. Any degradation in our competitive position could have a material adverse effect on our business, financial condition and results of operations.

Negative perceptions regarding the safety, quality or other attributes of our products or a failure or a perceived failure of our products could have a material adverse effect on our results of operations and could make us unable to continue our business.

Given the history of asbestos as an insulation material, we believe that there is an elevated level of attention towards perceived health and safety risks in the insulation industry. As a consequence, it is essential to our existing business and to our future growth that our products are considered safe. Even modest perceptions by existing or potential distributors, contractors or end-use customers in our target markets that our products are not safe could have a critical impact on our ability to sell our products and to continue as a business. Further, our competitors have in the past, and may in the future, seek to create or perpetuate such perceptions. There is risk of an actual or perceived failure of our products or other negative perceptions regarding our products, such as perceived health hazards. For example, dust is produced by our products during their installation and use, which increases the likelihood of the perception of a hazard. Another example is the potential in very high temperature applications for material failure. Like most insulation products, our Pyrogel XT and XTE products will normally go through a controlled burn-in process immediately after exposure to high temperatures. If installed improperly, the burn-in may proceed too rapidly and the material may become damaged. In addition, the thermal performance of our materials may degrade over time due to a variety of operational or environmental conditions. We take steps to educate our distributors, contractors, OEMs and end-use customers on the nature of our products and the proper installation and operating procedures in order to mitigate these risks. Such an event, or the perception of such an event, could quickly result in our direct and end-use customers replacing our products with traditional insulation materials which could have a material adverse effect on our results of operations.

Our activities and operations are subject to numerous health and safety laws and regulations. If we violate such regulations, we could face penalties and fines or be required to curtail or cease operations.

We are subject to numerous health and safety laws and regulations in each of the jurisdictions in which we operate. These health and safety laws and regulations apply to us including with regard to hazardous substances that we use in our manufacturing process and that certain of our products contain. These substances include titanium dioxide, iron oxide, ethanol and carbon black, each of which has been determined, in certain forms, with certain contaminants and at certain levels, to be hazardous, possibly carcinogenic or otherwise harmful to humans. We may also consider and adopt the use of other hazardous substances or substances potentially containing hazardous contaminants, with similar or higher risks in connection with new products or modifications to our current products and related manufacturing.

Our processes also require the use of other regulated substances in raw material delivery and manufacturing, including among others, ethanol. Applicable laws and regulations require us to obtain and maintain permits and approvals and implement health and safety programs and procedures to control risks associated with our operations. Compliance with those laws and regulations can require us to incur substantial costs. Moreover, if our compliance programs are not successful, we could be subject to penalties or to revocation of our permits, which may require us to curtail or cease operations of the affected facilities. In particular, the construction of future, potential facilities will require us to obtain and maintain new permits from various regulatory authorities and if the issuance of such permits is delayed or denied, it would slow or potentially prevent the expansion of our manufacturing capacity. Violations of laws, regulations and permit requirements may also result in criminal sanctions, injunctions and the denial or revocation of our various permits.

While we use hazardous substances, including titanium dioxide, carbon black and similar chemicals, in forms and at levels that are subject to current rules and regulations, such rules and regulations may become more stringent such that we are required to modify our manufacturing process and such that our customers' use of our products may be impacted. Regulatory changes contemplated in several countries, particularly in Europe, may substantially increase these risks. Changes in the products or manufacturing processes may require the customers to perform an extensive re-qualification process, which our customers may not want to undertake for various reasons, resulting in the customer switching to competing products. In addition, changes in our production or manufacturing process may result in uses above currently permitted levels. Such uses or changes in rules or regulations could materially adversely affect our business, financial condition and results of operations.

Health and safety laws, regulations and permit requirements may become more stringent or otherwise change. Any such changes could require us to incur materially higher costs than at present. Our costs of complying with current and future health and safety laws, regulations and permit requirements, and any liabilities, fines or other sanctions resulting from violations of them, could adversely affect our business, financial condition and results of operations.

We may face certain product liability or warranty claims on our products, including from improper installation of our products by third parties. As a consequence, we could lose existing and future business and our ability to develop, market and sell our insulation could be harmed.

The design, development, production and sale of our products involve an inherent risk of product liability claims and associated adverse publicity. We seek to lower our manufacturing costs, while maintaining appropriate performance characteristics, and to improve the per square foot costs of our silica aerogel blankets by optimizing our formulations to reduce material costs. If our products do not function as represented as a result of such changes in formulations, we may face warranty claims on our products. In addition, we may be named directly in product liability suits relating to our products, even for defects resulting from errors of our distributors, contractors, OEMs, partners or end-use customers. These claims could be brought by various parties, including distributors, contactors, OEMs, partners and other direct end-use customers who are purchasing products directly from us, or end-use customers who purchase our products from our distributors. We could also be named as co-parties in product liability suits that are brought against the distributors, contractors, OEMs, partners and end-use customers. Our products are often installed in our end-use customers' complex and capital intensive facilities in inherently hazardous or dangerous environments, including in the energy, petrochemical and power generation industries, where the potential liability from risk of loss could be substantial. The failure of our products to perform to customer expectations, whether or not because of improper installation, could give rise to warranty claims against us. We take steps to educate our distributors, contractors, OEMs, partners and end-use customers about the proper installation procedures to mitigate the risk of an uncontrolled burn-in for very high temperature applications of Pyrogel XT and XTE. However, installation of our products is handled by third parties over whom we have no control and errors or defects in their installation may also give rise to claims against us, diminish our brand or divert our resources from other purposes. Any of these claims, even if without merit, could result in costly litigation or divert management's attention and resources. In addition, many of our products are integrated into the final products of our customers. The integration of our products may entail the risk of product liability or warranty claims based on malfunctions or hazards from both our products and the final products of our customers.

A material product liability claim may seriously harm our results of operations, as well as damage our customer relationships and reputation. Although we carry general liability insurance, our current insurance coverage could be insufficient to protect us from all liability that may be imposed under these types of claims. In addition, our distributors, contractors, OEMs, partners and end-use customers may not have adequate insurance to cover against potential claims. If claims or losses exceed our liability insurance coverage, we may go out of business. In addition, insurance coverage is expensive, may be difficult to obtain and may not be available in the future on acceptable terms or at all. A significant increase in the cost of insurance coverage could adversely affect our business, financial condition and results of operations.

We may incur significant costs complying with environmental, health and safety laws and related claims, and failure to comply with these laws and regulations could expose us to significant liabilities, which could materially adversely affect our results of operations.

Costs of compliance with regional, national, state and local existing and future environmental, health and safety laws and regulations could adversely affect our cash flow and results of operations. We are required to comply with numerous environmental laws and regulations and to obtain numerous governmental permits in order to operate our facilities and in connection with the design, development, manufacture and transport of our products and the storage, use, handling and disposal of hazardous substances, including environmental, health and safety laws, regulations and permits governing air emissions or water usage and disposal. We may incur significant additional costs to comply with these requirements, which requirements are becoming stringent in a progressive manner. If we fail to comply with these current and new requirements, we could be subject to civil or criminal liability, damages and fines, require substantial capital investment to remedy non-compliance, and our operations could be curtailed, suspended or shutdown. In addition, certain foreign laws and regulations may affect our ability to export products outside of the United States. Existing environmental, health and safety laws and regulations could be revised or reinterpreted and new laws and regulations could be adopted or become applicable to us or our products, and future changes in environmental, health and safety laws and regulations could occur. These factors may materially increase the amount we must invest to bring our processes into compliance and impose additional expense on our operations.

Among the changes to environmental laws and regulations that could occur is the adoption of regulatory frameworks to reduce greenhouse gas emissions, which a number of countries, particularly in the European Union, have adopted, or are considering adopting, including the 2015 Paris Agreement on climate change. These include adoption of cap and trade regimes, carbon taxes, restrictive permitting, increased efficiency standards, and incentives or mandates for renewable energy, any of which could increase the costs of manufacturing our products and increase our compliance costs, and/or reduce demand for our products from our customers in the energy industry, all of which could materially adversely affect our business and results of operations. In spite of the United States having formally withdrawn from the 2015 Paris Agreement recently, our customer base and operations are global in nature, which requires continued adaptations to these emerging requirements.

In addition, private lawsuits, including claims for remediation of contamination, personal injury or property damage, or actions by regional, national, state and local regulatory agencies, including enforcement or cost-recovery actions, may materially increase our costs. Certain environmental laws make us potentially liable on a joint and several basis for the remediation of contamination at or emanating from properties or facilities that we currently or formerly owned or operated or properties to which we arranged for the disposal of hazardous substances. Such liability may require us to pay more than our fair share and could require us to address contamination caused by others. For example, the site of our East Providence facility contains certain levels of contamination caused by prior third-party activities on and near the site. Such contamination remains in place under a state-approved deed restriction, and we are required to comply with such deed restriction and the accompanying soil management plan. In general, the deed restriction prohibits the residential use of the property and the use of groundwater as potable water, and requires the maintenance of engineering controls and annual inspections to help prevent exposure to contaminated soils. The soil management plan requires us to notify the state environmental agency with respect to any soil excavation, stockpiling, sampling and off-site disposal of excavated soil. Although we have not had to make material expenditures to satisfy these requirements to date, in the future, we may incur additional costs to comply with these requirements and failure to do so could disrupt the operation of our facility or could subject us to liability for environmental remediation. We may incur liability relating to the remediation of contamination, including contamination we did not cause. Furthermore, ethanol, one of the materials that we handle in large quantities in our manufacturing process is subject to additional laws and regulations including those administered by the U.S. Alcohol and Tobacco Tax and Trade Bureau. While we seek to comply with the stringent requirements of these laws and regulations, these laws and regulations are complex and are subject to interpretation. Any changes in these laws or regulations or any interpretation thereof, or changes in our manufacturing processes may require us to request changes to our existing permits or obtain new permits. Any requests to change our existing permits or obtain new permits may be delayed or denied and may require us to modify our manufacturing processes, which could be costly and time consuming and could adversely affect our business and results of operations.

We may not be able to obtain or maintain, from time to time, all required environmental regulatory approvals. A delay in obtaining any required environmental regulatory approvals or failure to obtain and comply with them could materially adversely affect our business and results of operations.

Breakdowns, security breaches, loss of data and other disruptions of our information technology systems could compromise sensitive information related to our business, prevent us from accessing critical information and expose us to liability, which would cause our business and reputation to suffer.

In the ordinary course of our business, we collect and store sensitive data, including intellectual property, our proprietary business information and that of our suppliers, customers and business partners, and personally identifiable information about our employees. We manage and maintain our applications and data utilizing on-site and off-site systems. These applications and data encompass a wide variety of business critical information including research and development information, commercial information and business and financial information.

The secure processing, storage, maintenance and transmission of this critical information is vital to our operations and business strategy, and we devote resources to protecting such information. Although we take measures to protect sensitive information from unauthorized access or disclosure, our information technology and infrastructure may be vulnerable to breakdowns, attacks by hackers, viruses, breaches or interruptions due to employee error, malfeasance or other disruptions, or lapses in compliance with privacy and security mandates. Any such virus, breakdown, attack, breach or interruption could compromise our networks and the information stored there could be accessed by unauthorized parties, publicly disclosed, lost or stolen. We have measures in place that are designed to detect and respond to such security incidents and breaches of privacy and security mandates, but there can be no assurance that our efforts will prevent such breakdowns or breaches in our systems. Recently, a specific kind of cyber threat, targeted mostly at small and medium-sized enterprises involves the so called “ransomware” attacks in which a hostile actor breaches the security of the information network and locks down the network to prohibit access to the system from its intended users. The hostile actor demands monetary payments in exchange for releasing the network to allow its normal operation. We may not be able to pay such actors on financial or legal grounds and even if such payments are made, there is no guarantee such actors would follow through with the promise to release the network. Any such breach, access, disclosure or other loss of information or access could result in legal claims or proceedings, liability under laws that protect the privacy of personal information or other laws, government enforcement actions and regulatory penalties. Unauthorized access, loss or dissemination could also disrupt our operations, customer support services, research and development activities, capture of company financial information, various general and administrative aspects of our business and damage our reputation, any of which could adversely affect our business.

Our contracts with U.S. government agencies may subject us to audits, criminal penalties, sanctions and other expenses and fines.

We perform contract research services for U.S. government agencies and our products are sold to customers that may incorporate them into government projects. U.S. government agencies, including the Defense Contract Audit Agency and the Department of Labor, routinely audit government contractors. These agencies review a contractor's compliance with contract terms and conditions, performance under its contracts, cost structure and compliance with applicable laws, regulations and standards. The U.S. government also may review the adequacy of a contractor's systems and policies, including a contractor's purchasing, property, estimating, billing, accounting, compensation and management information systems. Any costs found to be overcharged or improperly allocated to a specific contract or any amounts improperly billed or charged for products or services will be subject to reimbursement to the government. As a government contractor, we are required to disclose to the U.S. government credible evidence of certain violations of law and contract overpayments. If we are found to have participated in improper or illegal activities, we may be subject to civil and criminal penalties and administrative sanctions, including termination of contracts, forfeiture of profits, suspension of payments, fines and suspension or prohibition from doing business with the U.S. government. Any negative publicity related to such contracts, regardless of the accuracy of such publicity, may adversely affect our business or reputation.

Our contracts with U.S. government agencies may not be funded by future appropriations and are subject to modification or termination at any time prior to their completion.

Our contracts with U.S. government agencies are subject to the availability of appropriated funds. The U.S. government funds our contract research work through a variety of funding programs that rely on monies appropriated by Congress. At any point, the availability of funding could change, thus reducing the opportunities for continued revenues to us from government contract work. Revenue from contracts with U.S. government agencies constituted 2% of our total revenue in 2019, 2018 and 2017.

In addition, under our contracts, the U.S. government generally has the right not to exercise options to extend or expand our contracts and may modify, curtail or terminate the contracts at its convenience. Our government customers may not renew our existing contracts after the conclusion of their terms and we may not be able to enter into new contracts with U.S. government agencies. Any decision by the U.S. government not to exercise contract options or to modify, curtail or terminate our contracts or not to renew our contracts or enter into new contracts with us would adversely affect our revenues.

If we lose key personnel upon whom we are dependent, or if we are unable to successfully recruit and retain skilled employees, we may not be able to manage our operations and meet our strategic objectives.

Our continued success depends to a considerable degree upon the continued services of a small number of our employees with critical knowledge of our products, our manufacturing process, our intellectual property, our customers and our global operations. The loss or unavailability of any of these individuals could harm our ability to execute our business plan, maintain important business relationships and complete certain product development initiatives, which could harm our business. In the event that any of these key individuals leave their employment with us or take new employment with a competitor, our business and results of operations could be materially adversely affected. In addition, our continued success depends upon the availability, contributions, vision, skills, experience and effort of our senior management, financial, sales and marketing, engineering and production teams. We do not maintain "key person" insurance on any of our employees. We have entered into employment agreements with certain members of our senior management team, but none of these agreements guarantee the services of the individual for a specified period of time. All of the agreements with members of our senior management team provide that employment is at-will and may be terminated by the employee at any time and without notice.

The loss of the services of any of key employees might impede our operations or the achievement of our strategic and financial objectives. The loss or interruption of the service of any of these individuals or our inability to attract or retain other qualified personnel or advisors could have a material adverse effect on our business, financial condition and results of operations and could significantly reduce our ability to manage our operations and implement our strategy.

Our ability to use our net operating loss carryforwards may be subject to limitation, which could result in a higher effective tax rate and adversely affect our financial condition and results of operations.

During 2014, we performed analyses pursuant to Section 382 of the Internal Revenue Code of 1986, as amended, or the Internal Revenue Code, as well as similar state provisions, in order to determine whether any limitations might exist on the utilization of net operating losses and other tax attributes. Generally, a change of more than 50% in the ownership of a company's stock, by value, over a three year period constitutes an ownership change for U.S. federal income tax purposes. An ownership change may limit a company's ability to use its net operating loss carryforwards attributable to the period prior to such change. Based on these analyses, we determined that it is more likely than not that an ownership change occurred on June 18, 2014 upon the closing of our IPO, resulting in an annual limitation on the use of our net operating losses and other tax attributes as of such date. As a result, our prior net operating losses were limited to $155.2 million, including built-in gains of $42.0 million at the date of that ownership change. The use of our net operating loss carryforwards may be restricted further in the event of any future changes in our ownership.

Risks Related to Our Intellectual Property

Our inability to protect our intellectual property rights could negatively affect our business and results of operations.

Our ability to compete effectively depends in part upon developing, maintaining and/or protecting intellectual property rights relevant to our aerogel product forms, applications, manufacturing technologies and brand names. We rely principally on a combination of patent protection, trade secret laws, confidentiality and nondisclosure agreements, trademark registrations, common law rights and licensing arrangements to establish and protect the intellectual property rights relevant to our business. However, these measures may not be adequate in every given case to permit us to gain or keep any competitive advantage, particularly in those countries where the laws do not protect our proprietary rights as fully as or where the enforcement tools are weaker or less effective than those in the United States. In particular, since aerogels were developed approximately 80 years ago, there has been a wide range of research, development and publication related to aerogels, which makes it difficult to establish intellectual property rights to many key elements of aerogel technology and to obtain patent protection. Accordingly, much of the general technology that we use in our manufacture of aerogel blankets is not protected by patents.

Where we consider it appropriate, our strategy is to seek patent protection in the United States and other countries on technologies used in or relating to our aerogel product forms, applications and manufacturing technologies. As of December 31, 2019, we had 47 issued U.S. patents and 98 issued foreign patents, including five U.S. patents and 19 foreign patents that we co-own with third parties. The issuance of a patent is not conclusive as to its scope, validity or enforceability. Thus, any patent held by us or to be issued to us from a pending patent application, could be challenged, invalidated or held unenforceable in litigation or proceedings before the U.S. Patent and Trademark Office, or USPTO, and/or other patent tribunals in the United States or in foreign jurisdictions. Third parties could develop technologies that circumvent the patent protection we have secured. No consistent policy regarding the breadth of patent claims has emerged to date in the United States and the landscape could become more uncertain in view of future rule changes by the USPTO, the introduction of patent reform legislation and decisions in patent law cases by the federal courts including the United States Supreme Court.

The patent landscape outside the United States is even less predictable. As a result, the validity and enforceability of patents cannot be predicted with certainty. For example, we are aware of competitors that manufacture and market aerogel insulation products in China, where it may be difficult for us to enforce our intellectual property rights against these or other competitors.

In May 2016, we filed a complaint for patent infringement against Nano Tech Co., Ltd. (Nano), and Guangdong Alison Hi Tech., Ltd. (Alison) in the International Trade Commission, or ITC. In the ITC complaint, we alleged that these two China-based companies have engaged and are engaging in unfair trade practices by importing aerogel products in the United States that infringe, and/or are manufactured by processes that infringe, several of our patents in violation of Section 337 of the Tariff Act of 1930. In the ITC complaint, we sought exclusion orders from the ITC that direct the United States Customs and Border Protection to stop the importation of these infringing products. In February 2018, the ITC issued its final determination confirming the ALJ's previous initial determination that Nano and Alison had infringed asserted Aspen patents and that they have not proven the patents are invalid except with respect to one dependent product claim, which the ITC found was not infringed. The ITC affirmed that Alison and Nano each violated Section 337 of the Tariff Act and issued a limited exclusion order prohibiting importation of infringing aerogel insulation products manufactured by Alison and Nano. Alison unsuccessfully appealed the ITC determination with respect to a product patent to the United States Court of Appeals for the Federal Circuit (CAFC), which affirmed the validity of Aspen's patent. The exclusion order, which is enforced by the United States Customs and Border Protection, is currently in effect. Additionally, the United States Patent and Trademark Office, or USPTO, denied Alison's requests to invalidate the claims of four of Aspen's patents in Inter-Partes Review. Alison also filed multiple similar requests with the Chinese Patent Office, or SIPO, seeking to invalidate our Chinese manufacturing process patents and two of our Chinese product patents. With respect to one of those request, not withdrawn previously by Alison, the Patent Reexamination Board of SIPO (PRB), issued a decision upholding the validity of Aspen's issued patent as amended in the proceedings. Alison has appealed the PRB's decision to the Beijing IP court. After the oral hearing at the Beijing IP court, we are awaiting the decision by the court. Nano has also filed a request seeking invalidation of a product patent at PRB of SIPO on which oral hearing took place in July 2019. After the oral hearing, Nano withdrew its invalidation request. On September 23, 2019, Alison filed yet another request to invalidate the same patent, whose prior validity opinion by PRB is currently on appeal at the Beijing IP Court. After conducting an oral hearing, PRB issued a decision on January 23, 2020 denying Alison's latest invalidation request of this patent.

In April 2016, we also filed a patent infringement suit at the District Court in Mannheim, Germany (Mannheim court), against Nano, Alison and two European resellers asserting their infringement of one of our German patents. We subsequently asserted infringement of another three patents against Nano, Alison and a European reseller of Alison's products at the Mannheim court. We have since settled with one European reseller in exchange for a commitment not to procure infringing products and cooperation with our case. In January 2018, the court issued a series of judgments by acknowledgement (German, "Anerkenntnisurteil") finding the second reseller, Hiltex, liable for infringement and also issued injunctions against Hiltex. The judgments resulted from a settlement agreement in which Hiltex agreed not to resell the infringing products in Europe where at least one of the asserted patents are active. Nano and Alison also initiated nullity actions in German Federal Patent Court in Munich against our asserted German patents.

On March 8, 2019, Mannheim court issued two separate judgments in the cases against Nano and Alison, respectively. The Mannheim court determined that both Nano and Alison are infringing on Aspen's EP1638750 (750 Patent) in connection with their respective products. The court also issued injunctions prohibiting the offer, putting on the market, using, importing or possessing the infringing products. The court found the defendants liable to us for damages since September 22, 2012. The court also ordered the defendants to provide information on the scope of the acts of infringement committed since August 22, 2012, and a recall of infringing products. The court also ordered Nano and Alison to bear the costs of the legal proceedings and reimburse statutory attorneys' costs and expenses to us, that exact amount of which is yet to be determined. Nano and Alison have appealed the judgments of the Mannheim Court. The appeal is currently ongoing. The Federal Patent Court in Munich previously dismissed the challenge to the validity of 750 Patent which has become final.

Nano and Alison also filed an opposition to one of the asserted patents at the European Patent Office (EPO). In December 2018, the opposition division of EPO determined the patent, EP2813338 (338 Patent), was invalid on formality grounds and decided to revoke it, which determination is currently under appeal at the EPO Board of appeals. On March 19 and 20, 2019 the German Federal Patent Court in Munich conducted oral proceedings and voided four claims in EP2415577 (577 Patent) and confirmed the validity of challenged claims in EP2422950 (950 Patent) within the scope of silica gels. The Mannheim court issued two judgments on December 23, 2019 finding that Alison infringed 577 Patent and 950 Patent and also issued injunctions prohibiting Alison from continuing infringement in connection with any aerogel sheets. As of March 6, 2020, we are unaware of any timely appeal of these December 2019 decisions by Alison. Upon confirmation of the same by the Mannheim Court, we expect the decisions to become final. The infringement proceedings at the Mannheim court based on 577 Patent and 950 Patent are currently ongoing against Nano.

Additionally, a reseller of Nano's products in Taiwan challenged the validity of one of our patents in Taiwan in 2018. After careful review of our written response, the Taiwanese patent office has determined the patent as valid and dismissed the challenge in December 2018. In 2018, LG Chem Ltd. challenged the validity of one of our patents in Korea at the Intellectual Property Trial and Appeals Board (IPTAB) of the Korean Intellectual Property Office. After conducting an oral hearing, the IPTAB issued a decision on November 30, 2019 upholding claims related to aerogel sheets incorporating fibers and invalidating claims for aerogel sheets not incorporating fibers. The IPTAB decision is currently on appeal at the Korean Patent Court.

Due to their nature, it is difficult to predict the outcome or the costs involved in any litigation or administrative proceedings, including any appeals process. Furthermore, the counter-parties in these proceedings may have significant resources and interest to litigate and therefore, these litigation matters could be protracted and may ultimately involve significant legal expenses. In addition to the foregoing, we have been and may be from time to time a party to other legal proceedings that arise in the ordinary course of business and to other patent enforcement actions to assert our patent rights.

In addition, we may fail to apply for patents on important technologies or innovative products in a timely fashion, if at all, and our existing and future patents may not be sufficiently broad to prevent others from practicing our technologies or from developing competing products or technologies, in particular given the long history of aerogel development. Furthermore, third parties could practice our intellectual property rights in territories where we do not have patent protection or where processes for remedies for infringement of intellectual property or unclear or still evolving. Such third parties may then try to import products made using our intellectual property rights into the United States or other countries. We may not be able to prevent such imports practically even if we obtain appropriate legal remedies. Our strategy is to seek registration of trademarks for our brands in many, but not all, of the jurisdictions in which we sell our products based on various factors, including our sales volumes in the jurisdiction, our ability to enforce local laws and cost. Our strategy may not be adequate to protect our brands in all circumstances, especially in foreign jurisdictions. In certain jurisdictions, third parties may seek to register trademarks on the names of our products and brands before we do thus requiring us to change branding strategies or otherwise deal with the issue.

As of December 31, 2019, we had 21 pending U.S. patent applications and 75 pending foreign patent applications, including one pending U.S. patent application and 14 foreign pending patent applications that we co-own with other third parties. Our pending patent applications are directed to various enabling technologies for the product forms, applications and manufacturing technologies that support our current business, as well as aspects of products under development or contemplated for the future. The issuance of patents from these applications involves complex legal and factual questions and, thus, we cannot provide assurance that any of our pending patent applications will result in the issuance of patents to us. The USPTO, relevant foreign patent offices and other relevant patent tribunals may deny or require significant narrowing of claims in our pending patent applications. Patents issued as a result of any of our pending patent applications may not cover our enabling technology and/or the products or processes that support our current or future business or afford us with significant commercial protection against others with similar technology. Proceedings before the USPTO could result in adverse decisions as to the priority of our inventions and the narrowing or invalidation of claims in issued patents. In addition, our pending patent applications filed in foreign countries are subject to laws, rules and procedures that differ from those of the United States, and thus foreign patent applications may not be granted even if counterpart United States patents are issued.

We have initiated intellectual property litigation that is and will continue to be costly, and could limit or invalidate our intellectual property rights, divert time and efforts away from business operations, require us to pay damages and/or costs and expenses and/or otherwise have an material adverse impact on our business, and we could become subject to additional such intellectual property litigation in the future.

The success of our business is highly dependent on protecting our intellectual property rights. Unauthorized parties may attempt to copy or otherwise obtain and use our products and/or enabling technology. Policing the unauthorized use of our intellectual property rights is difficult and expensive, as is enforcing these rights against unauthorized use by others. Identifying unauthorized use of our intellectual property rights is difficult because we may be unable to monitor the technologies and/or materials being employed by other parties. The steps we have taken or will take may not prevent unauthorized use of our intellectual property rights, particularly in foreign countries where enforcement of intellectual property rights may be more difficult than in the United States.

In May 2016, we filed a complaint for patent infringement against Nano Tech Co., Ltd. (Nano), and Guangdong Alison Hi Tech., Ltd. (Alison) in the International Trade Commission, or ITC. In the ITC complaint, we alleged that these two China-based companies have engaged and are engaging in unfair trade practices by importing aerogel products in the United States that infringe, and/or are manufactured by processes that infringe, several of our patents in violation of Section 337 of the Tariff Act of 1930. In the ITC complaint, we sought exclusion orders from the ITC that direct the United States Customs and Border Protection to stop the importation of these infringing products. In February 2018, the ITC issued its final determination confirming the ALJ's previous initial determination that Nano and Alison had infringed asserted Aspen patents and that they have not proven the patents are invalid except with respect to one dependent product claim, which the ITC found was not infringed. The ITC affirmed that Alison and Nano each violated Section 337 of the Tariff Act and issued a limited exclusion order prohibiting importation of infringing aerogel insulation products manufactured by Alison and Nano. Alison unsuccessfully appealed the ITC determination with respect to a product patent to the United States Court of Appeals for the Federal Circuit (CAFC), which affirmed the validity of the Aspen's patent. The exclusion order, which is enforced by the United States Customs and Border Protection, is currently in effect. Additionally, the United States Patent and Trademark Office, or USPTO, denied Alison's requests to invalidate the claims of four of Aspen's patents in Inter-Partes Review. Alison also filed multiple similar requests with the Chinese Patent Office, or SIPO, seeking to invalidate our Chinese manufacturing process patents and two of our Chinese product patents. With respect to one of those requests, not withdrawn previously by Alison, the Patent Reexamination Board of SIPO (PRB), issued a decision upholding the validity of Aspen's issued patent as amended in the proceedings. Alison has appealed the PRB's decision to the Beijing IP court. After the oral hearing at the Beijing IP court, we are awaiting the decision by the court. Nano has also filed a request seeking invalidation of a product patent at PRB of SIPO on which the oral hearing took place in July 2019. After the oral hearing, Nano withdrew its invalidation request. On September 23, 2019, Alison filed yet another request to invalidate the same patent, whose prior validity opinion by PRB is currently on appeal at the Beijing IP Court. After conducting an oral hearing, PRB issued a decision on January 23, 2020 denying Alison's latest invalidation request of this patent.

In April 2016, we also filed a patent infringement suit at the District Court in Mannheim, Germany (Mannheim court), against Nano, Alison and two European resellers asserting their infringement of one of our German patents. We subsequently asserted infringement of another three patents against Nano, Alison and a European reseller of Alison's products at the Mannheim court. We have since settled with one European reseller in exchange for a commitment not to procure infringing products and cooperation with our case. In January 2018, the court issued a series of judgments by acknowledgement (German, "Anerkenntnisurteil") finding the second reseller, Hiltex, liable for infringement and also issued injunctions against Hiltex. The judgments resulted from a settlement agreement in which Hiltex agreed not to resell the infringing products in Europe where at least one of the asserted patents are active. Nano and Alison also initiated nullity actions in German Federal Patent Court in Munich against our asserted German patents.

On March 8, 2019, Mannheim court issued two separate judgments in cases against Nano and Alison, respectively. The Mannheim court determined that both Nano and Alison are infringing on Aspen's EP1638750 (750 Patent) in connection with their respective products. The court also issued injunctions prohibiting the offer, putting on the market, using, importing or possessing the infringing products. The court found the defendants liable to us for damages since September 22, 2012. The court also ordered the defendants to provide information on the scope of the acts of infringement committed since August 22, 2012, and a recall of infringing products. The court also ordered Nano and Alison to bear the costs of the legal proceedings and reimburse statutory attorneys' costs and expenses to us, that exact amount of which is yet to be determined. Nano and Alison have appealed the judgements of the Mannheim court. The appeal is currently ongoing. The Federal Patent Court in Munich previously dismissed the challenge to the validity of 750 Patent which has become final.

Nano and Alison also filed an opposition to one of the asserted patents at the European Patent Office (EPO). In December 2018, the opposition division of EPO determined the patent, EP2813338 (338 Patent) was invalid on formality grounds and decided to revoke it, which determination is currently under appeal at the EPO Board of appeals. On March 19 and 20, 2019 the German Federal Patent Court in Munich conducted oral proceedings and voided four claims in EP2415577 (577 Patent) and confirmed the validity of challenged claims in EP2422950 (950 Patent) within the scope of silica gels. The Mannheim court issued two judgments on December 23, 2019 finding that Alison infringed 577 Patent and 950 Patent and also issued injunctions prohibiting Alison from continuing infringement in connection with any aerogel sheets. As of March 6, 2020, we are unaware of any timely appeal of these December 2019 decisions by Alison. Upon confirmation of the same by the Mannheim Court, we expect the decisions to become final. The infringement proceedings at the Mannheim court based on 577 Patent and 950 Patent are currently ongoing against Nano.

Additionally, a reseller of Nano's products in Taiwan challenged the validity of one of our patents in Taiwan in 2018. After careful review of our written response, Taiwanese patent office has determined the patent as valid and dismissed the challenge in December 2018. In 2018, LG Chem Ltd. challenged the validity of one of our patents in Korea at the Intellectual Property Trial and Appeals Board (IPTAB) of the Korean Intellectual Property Office. After conducting an oral hearing, the IPTAB issued a decision on November 30, 2019 upholding claims related to aerogel sheets incorporating fibers and invalidating claims for aerogel sheets not incorporating fibers. The IPTAB decision is currently on appeal at the Korean Patent Court.

Due to their nature, it is difficult to predict the outcome or the costs involved in any litigation or administrative proceedings, including any appeals process. Furthermore, the counter parties in these proceedings may have significant resources and interest to litigate and therefore, these litigation matters could be protracted and may ultimately involve significant legal expenses. In addition to the foregoing, we have been and may be from time to time party to other legal proceedings that arise in the ordinary course of business and to other patent enforcement actions to assert our patent rights.

Our continued commercial success will also depend in part upon not infringing the patents or violating other intellectual property rights of third parties. We are aware of patents and patent applications generally relating to aspects of our technologies filed by, and issued to, third parties. Our knowledge of the patent landscape with respect to the technologies currently embodied within our aerogel products and the technologies that we practice in manufacturing those products indicates that the third-party patent rights most relevant to our business are those owned by Cabot and licensed to us under the cross license agreement with Cabot. Nevertheless, we cannot determine with certainty whether patents or patent applications of other parties may materially affect our ability to conduct our business. There may be existing patents of which we are unaware that we may inadvertently infringe, resulting in claims against us or our customers. In recent years, Chinese, Japanese and South Korean entities have filed a significant number of patent applications related to aerogel products in both their home countries and in foreign countries. These patents in application areas of aerogels may make it more difficult for OEMs and end-use customers in these countries to use our products in new and different applications, which in turn may limit our ability to penetrate new markets.

In the event that the manufacture, use and/or sale of our products or technologies is challenged, or if our product forms or technologies conflict with patent rights of others or our operations conflict with trademark or similar rights of others, third parties could bring legal actions against us in the United States, Europe or other countries, claiming damages and seeking to enjoin the manufacturing and/or marketing of our products. In addition, it is not possible to predict with certainty what patent claims may arise from pending patent applications of third parties. In the United States, for example, patent prosecution can proceed in secret prior to issuance of a patent, provided such application is not filed in a foreign jurisdiction. For U.S. patent applications that are also filed in foreign jurisdictions, such patent applications will not be published until 18 months from the filing date of the application. As a result, third parties may be able to obtain patents with claims relating to our product forms, applications and/or manufacturing processes which they could attempt to assert against us or our end-users.

In the case of any of the above, litigation may be necessary to enforce, protect or defend our intellectual property rights or to determine the validity and scope of the intellectual property rights of others. Any such litigation, including our ongoing patent enforcement actions described above, could be unsuccessful, cause us to incur substantial costs, divert resources and the efforts of our personnel away from daily operations, harm our reputation and/or result in the impairment of our intellectual property rights. In some cases, litigation may be threatened or brought by a patent holding company (otherwise known as non-practicing entities or patent "trolls") or other adverse patent owner who has no relevant product revenues and against which our patents may provide little or no deterrence. If we are found to infringe any patents, regardless of whether litigation is brought against us by third parties or, as in the case of our ongoing patent enforcement actions described above, brought by us against third parties, we could be required to:

- pay substantial monetary damages, including lost profits, reasonable royalties and/or treble damages if an infringement is found to be willful;
- totally discontinue or substantially modify any products or processes that are found to be in violation of another party's intellectual property rights; and/or
- seek a license to continue making and selling our products and/or using our manufacturing processes, which we may not be able to obtain on reasonable terms, if at all, which could significantly increase our operating expenses and/or decrease our revenue.

In the actions brought by us against third parties, including our ongoing patent enforcement actions described above, we may be required to pay costs and expenses of opposing parties, including attorney fees, if we lose.

If our competitors are able to use our technology without payment to us, our ability to compete effectively could be materially harmed. Our contracts generally indemnify our customers for third-party claims of intellectual property infringement related to the manufacture and use of our products, and typically up to the amount of the purchase price paid for the product, which could cause us to become involved, and subject to liability, in litigation between our customers and third parties. The expense of defending these claims may adversely affect our results of operations.

Patents covering technologies that are similar or superior to our technologies may be developed or obtained by third parties. We may need to seek licenses to these technologies, which could limit our ability to manufacture our products and have a material adverse effect on our business and results of operations.

Competitors or other third parties may independently develop and obtain patents covering technologies that are similar or superior to the product forms, applications or manufacturing technologies that we employ. In such event, we may need to obtain licenses for these technologies. However, we may not be able to obtain licenses on reasonable terms, if at all, which could limit our ability to manufacture our current and/or future products and operate our business.

Our contracts with the U.S. government and other third parties could negatively affect our intellectual property rights.

To further our product development efforts, our scientists and engineers work closely with customers, the U.S. government and other third parties to research and develop advancements in aerogel product forms, applications and manufacturing technologies. We have entered into agreements with private third parties and have been awarded numerous research contracts with the U.S. government to independently or jointly research, design and develop new devices and systems that incorporate aerogel material. We also expect to enter into similar private agreements and be awarded similar government contracts in the future. In some instances, the research and development activities that we conduct under contract with the U.S. government and/or with private third parties may produce intellectual property to which we may not have ownership or exclusive rights and will be unable to protect or monetize.

Moreover, when we develop new technologies using U.S. government funding, the government may obtain certain rights in any resulting patents, technical data and/or other confidential and proprietary information, generally including, at a minimum, a non-exclusive license authorizing the U.S. government to use the invention, technical data or software for non-commercial purposes. Federal government funding may limit when and how we can deploy our technology developed under those contracts. In addition, inventions must be reported promptly to the funding agencies, the federal funding must be disclosed in any resulting patent applications, and our rights in such inventions will normally be subject to government license rights, periodic post-contract utilization reporting, foreign manufacturing restrictions and "march-in" rights. March-in rights refer to the right of the U.S. government to require us to grant a license to the technology to a responsible applicant or, if we refuse, the government may grant the license itself. The U.S. government may exercise its march-in rights if it determines that action is necessary because we fail to achieve practical application of any technology developed under contract with the government or because action is necessary to alleviate health or safety needs, to meet requirements of federal regulations or to give preference to United States industry. The U.S. government may also have the right to disclose our confidential and proprietary information to third parties. In addition, failure to comply with all the government contract requirements may result in us losing the patent rights.

Our U.S. government-sponsored research contracts are also subject to audit and require that we provide regular written technical updates on a monthly, quarterly or annual basis, and, at the conclusion of the research contract, a final report on the results of our technical research. Because these reports are generally available to the public, third parties may obtain some aspects of our confidential and proprietary information relating to our product forms, applications and/or manufacturing processes. If we fail to provide these reports or to provide accurate and complete reports, the U.S. government could obtain rights to any intellectual property arising from the related research.

Furthermore, there could be disputes between us and a private third party as to the ownership rights to any inventions that we develop in collaboration with such third party. Any such dispute may cause us to incur substantial costs including potential license obligations, and could place a significant strain on our financial resources, divert the attention of management from our core business and harm our reputation.

We rely on trade secrets to protect our technology, and our failure to obtain or maintain trade secret protection could materially adversely affect our competitive business position.

We rely in part on trade secret protection to protect confidential and proprietary information relating to our technology, particularly where we do not believe patent protection is appropriate or obtainable. We continue to develop and refine the manufacturing technologies used to produce our aerogel products and believe that we have already developed, and will continue to develop, significant know-how related to these technologies. However, trade secrets can be difficult to protect. We may not be able to maintain the secrecy of this information and competitors may develop or acquire equally or more valuable information related to the manufacture of comparable aerogel products. Our strategy for scale-up of commercial production will continue to require us to share confidential and proprietary information with the U.S. government and other third parties. While we take reasonable efforts to protect our trade secrets, our employees, consultants, contractors or scientific and other advisors, or those of our business partners, may intentionally or inadvertently disclose our confidential and proprietary information to competitors. Any enforcement of claims by us that a third party has obtained and is using our trade secrets is expensive, time consuming and uncertain. In addition, foreign courts are sometimes less willing than United States courts to protect trade secrets.

We require all employees and consultants to execute confidentiality and/or nondisclosure agreements upon the commencement of an employment or consulting arrangement with us, which agreements generally require that all confidential and proprietary information developed by the individual or made known to the individual by us during the course of the individual's relationship with us be kept confidential and not disclosed to third parties. These agreements further generally provide that inventions conceived by the individual in the course of rendering services to us will be our exclusive property. Nevertheless, these agreements may not be honored and our confidential and proprietary information may be disclosed, or these agreements may be unenforceable or difficult to enforce. We also require customers and vendors to execute confidentiality and/or nondisclosure agreements. However, we have not obtained such agreements from all of our customers and vendors. Moreover, some of our customers may be subject to laws and regulations that require them to disclose information that we would otherwise seek to keep confidential. Our confidential and proprietary information may be otherwise disclosed without our authorization or knowledge. Moreover, third parties could reverse engineer our manufacturing processes, independently develop substantially equivalent confidential and proprietary information or otherwise gain access to our trade secrets. Additionally, cyber security threats, especially originating from countries such as China, Russia, Iran and North Korea as broadly reported in the media, pose a significant risk to maintaining control of our trade secrets. Failure to maintain trade secret protection could enable others to produce competing products and adversely affect our competitive business position.

Loss of the intellectual property rights that we license from Cabot Corporation would have a material adverse impact on our business.

We have licensed certain intellectual property rights from Cabot under a cross license agreement. These intellectual property rights have been critical to the manufacture of our existing products and may also be important to our research, development and manufacture of new products. Any loss of the intellectual property rights granted to us thereunder, including as a result of ineffective protection of such rights by Cabot, abandonment or expiration of the involved patents or a breach of or dispute under the agreement by either party would have a material adverse impact on our financial condition, results of operations and growth prospects, and might prevent us from continuing our business.

Risks Related to Our Data Privacy and Other Personal Information

We may be subject to, or may in the future become subject to, U.S. federal and state, and foreign laws and regulations imposing obligations on how we collect, use, disclose, store and process personal information. Our actual or perceived failure to comply with such obligations could result in liability or reputational harm and could harm our business. Ensuring compliance with such laws could also impair our efforts to maintain and expand our customer base, and thereby decrease our revenue.

We are subject to laws and regulations governing data privacy and other personal information. These laws and regulations govern our processing of personal data, including the collection, access, use, analysis, modification, storage, transfer, security breach notification, destruction and disposal of personal data. We must comply with laws and regulations associated with the international transfer of personal data based on the location in which the personal data originates and the location in which it is processed. Although there are legal mechanisms to facilitate the transfer of personal data from the European Economic Area, or EEA, and Switzerland to the United States, the decision of the European Court of Justice that invalidated the safe harbor framework has increased uncertainty around compliance with EU privacy law requirements. As a result of the decision, it was no longer possible to rely on safe harbor certification as a legal basis for the transfer of personal data from the European Union to entities in the United States. In February 2016, the European Commission announced an agreement with the Department of Commerce, or DOC, to replace the invalidated safe harbor framework with a new EU-U.S. "Privacy Shield." On July 12, 2016, the European Commission adopted a decision on the adequacy of the protection provided by the Privacy Shield. The Privacy Shield is intended to address the requirements set out by the European Court of Justice in its recent ruling by imposing more stringent obligations on companies, providing stronger monitoring and enforcement by the DOC and Federal Trade Commission and making commitments on the part of public authorities regarding access to information.

The privacy and security of personally identifiable information stored, maintained, received or transmitted, including electronically, subject to significant regulation in the United States and abroad. While we strive to comply with all applicable privacy and security laws and regulations, legal standards for privacy continue to evolve and any failure or perceived failure to comply may result in proceedings or actions against us by government entities or others, or could cause reputational harm, which could have a material adverse effect on our business.

U.S.-based companies may certify compliance with the privacy principles of the Privacy Shield. Certification to the Privacy Shield, however, is not mandatory. If a U.S.-based company does not certify compliance with the Privacy Shield, it may rely on other authorized mechanisms to transfer personal data.

The privacy and data security landscape is still in flux. In October 2016, an action for annulment of the European Commission decision on the adequacy of Privacy Shield was brought before the European Court of Justice by three French digital rights advocacy groups, La Quadrature du Net, French Data Network and the Fédération FDN. This case, Case T-738/16, is currently pending before the European Court of Justice. Should the European Court of Justice invalidate the Privacy Shield, it will no longer be possible to transfer data from the European Union to entities in the United States under a Privacy Shield certification, in which case other legal mechanisms would need to be put in place.

The legislative and regulatory landscape for privacy and data security continues to evolve, and there has been an increasing focus on privacy and data security issues which may affect our business. Failure to comply with current and future laws and regulations could result in government enforcement actions (including the imposition of significant penalties), criminal and civil liability for us and our officers and directors, private litigation and/or adverse publicity that negatively affects our business.

If we or our vendors fail to comply with applicable data privacy laws, or if the legal mechanisms we or our vendors rely upon to allow for the transfer of personal data from the EEA or Switzerland to the United States (or other countries not considered by the European Commission to provide an adequate level of data protection) are not considered adequate, we could be subject to government enforcement actions and significant penalties against us, and our business could be adversely impacted if our ability to transfer personal data outside of the EEA or Switzerland is restricted, which could adversely impact our operating results. The EU General Data Protection Regulation, which was effective as of May 25, 2018, introduced new data protection requirements in the European Union relating to the consent of the individuals to whom the personal data relates, the information provided to the individuals, the documentation we must retain, the security and confidentiality of the personal data, data breach notification and the use of third party processors in connection with the processing of personal data. The EU General Data Protection Regulation has increased our responsibility and potential liability in relation to personal data that we process, and we may be required to put in place additional mechanisms to ensure compliance with the EU General Data Protection Regulation. However, our ongoing efforts related to compliance with the EU General Data Protection Regulation may not be successful and could increase our cost of doing business. In addition, data protection authorities of the different EU member states may interpret the EU General Data Protection Regulation differently, and guidance on implementation and compliance practices are often updated or otherwise revised, which adds to the complexity of processing personal data in the European Union.

In the United States, California recently adopted the California Consumer Privacy Act of 2018, or CCPA, which came into effect in January 2020. The CCPA has been characterized as the first "GDPR-like" privacy statute to be enacted in the United States because it mirrors a number of the key provisions of the EU General Data Protection Regulation. The CCPA establishes a new privacy framework for covered businesses by creating an expanded definition of personal information, establishing new data privacy rights for consumers in the State of California, imposing special rules on the collection of consumer data from minors, and creating a new and potentially severe statutory damages framework for violations of the CCPA and for businesses that fail to implement reasonable security procedures and practices to prevent data breaches.

Risks Related to Our Common Stock

We have incurred and will continue to incur increased costs and demands upon management as a result of complying with the laws and regulations affecting public companies in the United States, which may adversely affect our results of operations.

As a public company, and particularly now that we are no longer an emerging growth company as of December 31, 2019, we have incurred and will continue to incur significant legal, accounting and other expenses that we did not incur as a private company. The Sarbanes-Oxley Act of 2002, the Dodd-Frank Wall Street Reform and Consumer Protection Act, the listing requirements of The New York Stock Exchange and other applicable securities rules and regulations impose various requirements on public companies, including establishment and maintenance of effective disclosure and financial controls and corporate governance practices. Our management and other personnel will need to devote a substantial amount of time to these compliance initiatives. Moreover, these rules and regulations will increase our legal and financial compliance costs and will make some activities more time-consuming and costly. We are subject to the reporting requirements of the Exchange Act that require us to file, among other things, quarterly reports on Form 10-Q and annual reports on Form 10-K. Under Section 302 of the Sarbanes-Oxley Act of 2002, or the Sarbanes-Oxley Act, as a part of each of these reports, our chief executive officer and chief financial officer are required to evaluate and report their conclusions regarding the effectiveness of our disclosure controls and procedures and to certify that they have done so. Effective internal controls are necessary for us to provide reliable financial reports and prevent fraud. Under Section 404 of the Sarbanes-Oxley Act, we have included a report of management on our internal control over financial reporting in our Form 10-K for our fiscal year ended December 31, 2019. In addition, since we are no longer an emerging growth company as of December 31, 2019, the independent registered public accounting firm auditing our financial statements is required to attest to and report on the effectiveness of our internal control over financial reporting for the year ended December 31, 2019 and subsequent years. We will also be required to hold a say-on-pay vote and a say-on-frequency vote at our 2020 Annual Meeting of Stockholders. The process of improving and documenting our internal controls and complying with Section 404 is expensive and time consuming, and requires significant attention of management. As we are no longer an emerging growth company, we are subject to increased regulatory requirements necessitating additional resources and attention from management and will result in increased costs to us, which could include higher legal fees, accounting fees and fees associated with investor relations activities, among others.

Complying with these requirements applicable to public companies may place a strain on our personnel, information technology systems and resources while diverting management's attention from other business concerns. We have engaged outside service providers with appropriate public company compliance experience and technical accounting knowledge to support our compliance efforts. We may need to engage additional service providers to ensure compliance which may cause us to incur additional operating costs.

These and other requirements may also make it more difficult or more costly for us to obtain or maintain certain types of insurance, including directors' and officers' liability insurance. We may be forced to accept reduced policy limits and coverage or incur substantially higher costs to obtain the same or similar coverage.

The impact of these requirements could also make it more difficult for us to attract and retain qualified persons to serve on our board of directors, our board committees or as executive officers. Any one of these requirements could have a material adverse effect on our business, financial condition and results of operations.

Because we are a public company, we are obligated to develop and maintain proper and effective internal control over financial reporting. If our internal controls over financial reporting are determined to be ineffective, or if our auditors are otherwise unable to attest to their effectiveness, investor confidence in our company, and our common stock price, may be adversely affected.

Pursuant to Section 404a of the Sarbanes-Oxley Act, we have furnished a report by management on the effectiveness of our internal control over financial reporting for the fiscal year ended December 31, 2019 and will continue to do so in each year thereafter. This assessment is required to include disclosure of any material weaknesses identified by our management in our internal control over financial reporting. Our independent registered public accounting firm is required to formally attest to the effectiveness of our internal control over financial reporting for the year December 31, 2019 and subsequent years.

We continue to assess our system of internal controls over financial reporting and successfully completed documentation necessary to perform the annual evaluation required to comply with Section 404. In future periods, we may discover, and not be able to remediate timely, significant deficiencies or material weaknesses. During the evaluation and testing process in 2019, we did not identify any material weaknesses in our internal controls over financial reporting. In future periods, if we were to identify one or more material weaknesses in our internal control, we may be unable to assert that our internal controls are effective. If we are unable to assert that our internal controls over financial reporting are effective, we could lose investor confidence in the accuracy and completeness of our financial reports or it could cause us to fail to meet our reporting obligations, which could have a material adverse effect on the price of our common stock. In addition, any failure to comply with Section 404 could subject us to a variety of administrative sanctions, including SEC action, ineligibility for short form resale registration, the suspension or delisting of our common stock from The New York Stock Exchange, and the inability of registered broker-dealers to make a market in our common stock, which would further reduce our stock price and could harm our business.

The trading market in our common stock has been limited and substantially less liquid than the average trading market for a stock quoted on The New York Stock Exchange.

Since our initial listing on The New York Stock Exchange on June 13, 2014, the trading market in our common stock has been limited and substantially less liquid than the average trading market for companies listed on The New York Stock Exchange. The listing of our common stock on The New York Stock Exchange does not assure that a meaningful, consistent and liquid trading market currently exists or will exist in the future. We cannot predict whether a more active market for our common stock will develop in the future. An absence of an active trading market could adversely affect our stockholders' ability to sell our common stock at current market prices in short time periods, or possibly at all. An inactive market may also impair our ability to raise capital by selling our common stock and may impair our ability to acquire other companies, products or technologies by using our common stock as consideration. Additionally, analyst coverage of our common stock may be limited and such lack of coverage may have a depressive effect on the market price for our common stock. As of December 31, 2019, approximately 36.1% of our outstanding shares of common stock were held by our executive officers, directors, principal stockholders and their respective affiliates, which may adversely affect the liquidity of the trading market for our common stock, in as much as federal securities laws restrict sales of our shares by these stockholders. If our affiliates continue to hold their shares of common stock, there will be a more limited trading volume in our common stock, which may make it more difficult for investors to sell their shares or increase the volatility of our stock price.

We expect that the price of our common stock will fluctuate substantially, which could subject us to securities class action litigation and result in substantial losses to our stockholders.

The price of our common stock fluctuates in a broad range. For example, on December 21, 2018 the closing price of our shares of common stock was $1.96 and on January 22, 2020, the closing price of our shares of common stock was $10.33. Such fluctuations may be due to a number of factors, including the following, some of which are beyond our control:

- volume and timing of orders for our products;
- quarterly and yearly variations in our or our competitors' results of operations;
- our announcement or our competitors' announcements regarding new products, product enhancements, significant contracts, number of distributors, acquisitions or strategic investments;
- announcements of technological innovations relating to aerogels, thermal management and energy infrastructure insulation;
- results of operations or projections that vary from the expectations of securities analysts and investors;
- the periodic nature of our sales cycles, in particular for capital projects in the energy infrastructure market;
- our ability to develop, obtain regulatory clearance or approval for and market new and enhanced products on a timely basis;
- future sales of our common stock, including sales by our executive officers, directors and significant stockholders and their respective affiliates;
- announcements by third parties of significant claims or proceedings against us, including with regard to intellectual property and product liability;

- changes in accounting principles; and
- general U.S. and global economic conditions and other factors, including factors unrelated to our operating performance or the operating performance of our competitors.

Furthermore, the U.S. stock market has at times experienced extreme volatility that in some cases has been unrelated or disproportionate to the operating performance of particular companies. These broad market and industry fluctuations may adversely affect the market price of our common stock, regardless of our actual operating performance.

In the past, following periods of market volatility, stockholders have instituted securities class action litigation. If we become involved in securities litigation, it could have a substantial cost and divert resources and the attention of our senior management team from our business regardless of the outcome of such litigation.

Securities analysts may not continue coverage of our common stock or may issue negative reports, which may have a negative impact on the market price of our common stock.

The trading market for our common stock relies in part on the research and reports that industry or financial analysts publish about us or our business. Securities analysts may elect not to provide research coverage of our common stock. If securities analysts do not cover or continue to cover our common stock, the lack of research coverage may cause the market price of our common stock to decline. If one or more of the analysts who elects to cover us downgrades our stock, our stock price would likely decline substantially. If one or more of these analysts ceases coverage of us, we could lose visibility in the market, which in turn could cause our stock price to decline. In addition, rules mandated by the Sarbanes-Oxley Act and a global settlement reached in 2003 between the SEC, other regulatory agencies and a number of investment banks have led to a number of fundamental changes in how analysts are reviewed and compensated. In particular, many investment banking firms are required to contract with independent financial analysts for their stock research. It may be difficult for companies such as ours, with smaller market capitalizations, to attract independent financial analysts that will cover our common stock. This could have a negative effect on the market price of our stock.

Our directors, officers and principal stockholders have significant voting power and may take actions that may not be in the best interests of our other stockholders.

As of December 31, 2019, our executive officers, directors and principal stockholders and their affiliates collectively controlled approximately 36.1% of our outstanding shares of common stock. As a result, these stockholders, if they act together, may be able to control the management and affairs of our company and certain matters requiring stockholder approval, including the election of directors and approval of significant corporate transactions. This concentration of ownership may have the effect of delaying or preventing a change of control and might adversely affect the market price of our common stock. This concentration of ownership may not be in the best interests of our other stockholders.

Anti-takeover provisions in our restated certificate of incorporation and restated bylaws, and Delaware law, could delay or discourage a takeover.

Anti-takeover provisions in our restated certificate of incorporation and restated bylaws and Delaware law may have the effect of deterring or delaying attempts by our stockholders to remove or replace management, engage in proxy contests and effect changes in control. The provisions of our charter documents include:

- procedures for advance notification of stockholder nominations and proposals;
- the inability of our stockholders to call a special meeting of the stockholders and the inability of our stockholders to act by written consent;
- the ability of our board of directors to create new directorships and to fill any vacancies on the board of directors;
- the ability of our board of directors to amend our restated bylaws without stockholder approval; and
- the ability of our board of directors to issue up to 5,000,000 shares of preferred stock without stockholder approval upon the terms and conditions and with the rights, privileges and preferences as our board of directors may determine.

In addition, as a Delaware corporation, we are subject to Delaware law, including Section 203 of the Delaware General Corporation Law. In general, Section 203 prohibits a Delaware corporation from engaging in any business combination with any interested stockholder for a period of three years following the date that the stockholder became an interested stockholder unless certain specific requirements are met as set forth in Section 203. These provisions, alone or together, could have the effect of deterring or delaying changes in incumbent management, proxy contests or changes in control.

Our restated certificate of incorporation designates a state or federal court located within the State of Delaware as the exclusive forum for certain types of actions and proceedings that may be initiated by our stockholders, which could limit our stockholders' ability to obtain a favorable judicial forum for disputes with us or our directors, officers or employees.

Our restated certificate of incorporation provides that, subject to limited exceptions, a state or federal court located within the State of Delaware will be the exclusive forum for (1) any derivative action or proceeding brought on our behalf, (2) any action asserting a claim of breach of a fiduciary duty owed by any of our directors, officers or other employees to us or our stockholders, (3) any action asserting a claim against us arising pursuant to any provision of the Delaware General Corporation Law, our restated certificate of incorporation or our restated bylaws, or (4) any other action asserting a claim against us that is governed by the internal affairs doctrine. This exclusive forum provision does not apply to suits brought to enforce a duty or liability created by the Exchange Act. It could apply, however, to a suit that falls within one or more of the categories enumerated in the exclusive forum provision and asserts claims under the Securities Act, inasmuch as Section 22 of the Securities Act creates concurrent jurisdiction for federal and state courts over all suits brought to enforce any duty or liability created by the Securities Act or the rule and regulations thereunder. There is uncertainty as to whether a court would enforce such provision with respect to claims under the Securities Act, and our stockholders will not be deemed to have waived our compliance with the federal securities laws and the rules and regulations thereunder. Any person or entity purchasing or otherwise acquiring any interest in shares of our capital stock shall be deemed to have notice of and to have consented to the provisions of our restated certificate of incorporation described above. This choice of forum provision may limit a stockholder's ability to bring a claim in a judicial forum that it finds favorable for disputes with us or our directors, officers or other employees, which may discourage such lawsuits against us and our directors, officers and employees. Alternatively, if a court were to find these provisions of our restated certificate of incorporation inapplicable to, or unenforceable in respect of, one or more of the specified types of actions or proceedings, we may incur additional costs associated with resolving such matters in other jurisdictions, which could adversely affect our business and financial condition.

Our shareholders may experience future dilution as a result of future equity offerings.

In addition to the underwritten public offering we recently completed on February 18, 2020 resulting in the issuance of 1,955,000 additional shares of our common stock, we may offer additional shares of our common stock or other securities convertible into or exchangeable for our common stock in order to raise additional capital in the future. We cannot assure our shareholders that we will be able to sell shares or other securities in any other offering at a price per share that is equal to or greater than the price per share our shareholders paid for our shares. Investors purchasing shares or other securities in the future could have rights, preferences or privileges senior to those of our shareholders and our shareholders may experience dilution. Our shareholders may incur additional dilution upon the exercise of any outstanding stock options or warrants, the issuance of shares of restricted stock, the vesting of restricted stock units, or the issuance, vesting or exercise of other equity awards.

We do not intend to pay cash dividends in the foreseeable future and, consequently, our shareholders' ability to achieve a return on their investment will depend on appreciation in the price of our common stock.

We have never declared or paid cash dividends on our common stock and we do not intend to pay any cash dividends on our common stock in the foreseeable future. We currently expect to retain all available funds and any future earnings for use in the operation and expansion of our business. In addition, the terms of our revolving credit facility restrict our ability to pay dividends and any future credit facilities, loan agreements, debt instruments or other agreements may further restrict our ability to pay dividends. Payments of future dividends, if any, will be at the discretion of our board of directors after taking into account various factors, including our business, results of operations and financial condition, current and anticipated cash needs, plans for expansion and any legal or contractual limitations on our ability to pay dividends. As a result, capital appreciation, if any, of our common stock will be our shareholders' sole source of potential gain for the foreseeable future.

CAUTIONARY STATEMENT REGARDING FORWARD-LOOKING STATEMENTS

This report includes forward-looking statements within the meaning of Section 27A of the Securities Act of 1933, as amended, or the Securities Act, and Section 21E of the Exchange Act that relate to future events or our future financial performance and involve known and unknown risks, uncertainties and other factors that may cause our actual results, levels of activity, performance or achievements to differ materially from any future results, levels of activity, performance or achievements expressed or implied by these forward-looking statements. Words such as, but not limited to, "believe," "expect," "anticipate," "estimate," "intend," "seek," "may," "plan," "potential," "predict," "project," "targets," "likely," "will," "would," "could," "should," "continue," and similar expressions or phrases, or the negative of those expressions or phrases, are intended to identify forward-looking statements, although not all forward-looking statements contain these identifying words. Although we believe that we have a reasonable basis for each forward-looking statement contained in this report, we caution you that these statements are based on our projections of the future that are subject to known and unknown risks and uncertainties and other factors that may cause our actual results, level of activity, performance or achievements expressed or implied by these forward-looking statements, to differ. The description of our Business set forth in Item 1, the Risk Factors set forth in this Item 1A and our Management's Discussion and Analysis of Financial Condition and Results of Operations set forth in Item 7 as well as other sections in this report, discuss some of the factors that could contribute to these differences. These forward-looking statements include, among other things, statements about:

- the expected future growth of the market for our aerogel insulation and our continued gain in market share, in particular in the energy infrastructure insulation market and other markets we target;
- our expectation that our investment in incremental manufacturing and operating expense will sustain long-term growth in our existing markets and develop new business opportunities;
- our plans to continue to develop and optimize aerogel products for high-value applications within the building materials market and our plan to realize revenue from this market;
- our plans to develop and optimize aerogel products for potential commercialization within the electric vehicle market, including our program to optimize carbon aerogels to improve the performance and cost of lithium-ion batteries and our initiative to optimize our silica aerogel products to inhibit the spread of thermal runaway related battery fires in electric vehicles;
- our plans and expectations to partner with industry leaders in the battery and electric vehicle market or such partnerships resulting in products and technologies or otherwise in meaningful financial results;
- our pursuit of high-value opportunities for our aerogel products within different segments of the global insulation market, including the building materials market, and our plans to leverage our aerogel technology platform to develop innovative, aerogel enhanced products for applications in new markets, including the electric vehicle market;
- our plans to focus additional resources to continue to grow our share of the energy infrastructure insulation market;
- our pursuit of and the expected greater adoption of our products in the LNG and power generation markets and our expectation that product revenue will be generated in large part by demand for insulation associated with scheduled plant shutdowns, or turnarounds, and other maintenance-related projects;
- our expectation that our products will be specified during the design phase in a growing number of new plant construction and capital expansion projects and our expectation that we will have an increasing percentage of our products sold for use in capital projects;
- our expectation that the growth in global energy demand will result in increased new-build and large capacity expansion projects, driving demand for our aerogel products;
- our plans to continue our strategy of working with innovative companies to target and penetrate additional market opportunities;
- our plans to develop strategic partnerships to facilitate market penetration beyond the energy infrastructure and building materials market, as well as the expected goals and priorities of such strategic partnerships;
- our belief that an adequate long-term supply of silica-precursor is available and our plans to reduce reliance on precursors susceptible to significant price fluctuations;
- our expectation in our ability to implement lower cost product formulations and realize material purchasing efficiencies;
- our belief that our portfolio of patents, trade secrets and know-how presents a significant barrier to potential new entrants in the production of aerogel blanket insulation;
- our expectation that we will be successful in enforcing and defending our patents against competitors and that such patents are valid and enforceable, as well as our expectations about the costs and consequences of our current or potential future patent litigation and the potential for additional patent litigation;
- our belief that our products possess strong competitive advantages over traditional insulation materials, including the superior thermal performance and the thin, easy-to-use and durable blanket form of our products;
- our plans to expand capacity at our East Providence, Rhode Island manufacturing facility;

- our expectation that expanded capacity in our East Providence, Rhode Island facility will become available or operational in a timely manner to support the long-term growth in demand we expect;
- our current estimate that the cumulative cost of the project to expand capacity in our East Providence, Rhode Island facility will be less than $5.0 million;
- our expectation that the completion of the project to expand capacity in our East Providence, Rhode Island facility will provide an additional annual nameplate capacity of 5 million square feet of aerogel blankets;
- our belief that we can finance the expansion of our existing manufacturing facility with anticipated available credit, cash flows from operations, debt financings, technology licensing agreements, customer prepayments or equity financings;
- our belief that our end-use customers will continue to invest in major energy infrastructure projects;
- our expectation that we will continue to sell our products in the building materials and other end markets;
- our expectation that we will develop, manufacture and sell new products and technologies through the strategic partnership with BASF SE and that our strategic partnership with BASF SE will facilitate our penetration of the building materials market;
- our joint development agreement with BASF SE, and the potential for it to support the development and commercialization of new aerogel products and technologies;
- our belief that the potential for significant technological innovation in traditional insulation materials is limited and that new high-performance materials will be required to meet evolving market requirements for energy efficient insulations systems;
- our belief that our aerogel products and manufacturing processes are proprietary and that we can protect our patents, trade secrets and know-how associated therewith;
- our belief that we can continue to improve the cost efficiency of our manufacturing process, that our current expansion plans offer attractive returns on incremental invested capital, and that we will focus our development efforts on new products and next generation technology with application in new, high value market segments;
- our belief that we will have opportunities to address additional high value applications in the estimated $3.1 billion global insulation market, and that we are well positioned to leverage a decade's worth of research and development to design and commercialize disruptive aerogel products for a wide array of new markets;
- our belief that our products have the lowest cost on a fully-installed basis or offer significant life-cycle cost savings in energy infrastructure and certain other applications as compared to traditional insulation materials;
- our plans to continue to expand our global sales force and distribution network to support anticipated growth in customers and demand for our products and our plans to seek to promote greater enterprise-wide utilization of our products by existing end-use customers;
- our belief that revenue growth will moderate due to a decrease in project-based demand in the subsea market and little to no growth in project-based demand in the LNG market;
- our expectations and projections about future revenues, revenue growth, costs, expenses, production volumes, manufacturing productivity, gross profit, profitability, net loss, loss per share and Adjusted EBITDA, sources and uses of cash, liquidity, cash flow, capital requirements and the sufficiency of our existing cash balance and available credit;
- our expectations that most of our revenue will continue to come from a relatively small number of customers for the foreseeable future;
- our expectations of long-term revenue growth, with increasing levels of gross profit and improved cash flows from operations and our expectations that we will incur significant capital expenditures related to the expansion of our manufacturing capacity to support this expected long term growth in demand;
- our expectations that the operating expenses will increase in both absolute dollars and as a percentage of revenue in 2020 but increase in absolute dollars and decrease as a percentage of revenue in the longer term, our research and development expenses will increase in both absolute dollars and as a percentage of revenue in 2020 but increase in absolute dollars and decrease as a percentage of revenue in the longer term, our sales and marketing expenses will increase in both absolute dollars and as a percentage of revenue in 2019 but increase in absolute dollars and decrease as a percentage of revenue in

the longer term, and our general and administrative expenses will remain increase in both absolute dollars and as a percentage of revenue in 2020 but increase in absolute dollars and decrease as a percentage of revenue in the longer term;

- our expectation to continue to increase investment in research and development in our efforts to enhance and expand our aerogel technology platform;
- our expectations about the impact of new accounting pronouncements on our consolidated financial statements and related disclosures;
- our belief that our experienced and dedicated leadership team will provide us with a competitive advantage in the industry;
- our belief of our technological and market leadership in aerogels;
- the expected future development of new aerogel technologies; and
- our expectations about limitations of net operating losses.

We may not actually achieve the plans, intentions or expectations disclosed in our forward-looking statements, and you should not place undue reliance on our forward-looking statements. Actual results or events could differ materially from the plans, intentions and expectations disclosed in the forward-looking statements we make. We have included important cautionary statements in this report, particularly in the Risk Factors set forth in Item 1A of this Annual Report on Form 10-K, that we believe could cause actual results or events to differ materially from the forward-looking statements that we make. Our forward-looking statements do not reflect the potential impact of any future acquisitions, mergers, dispositions, joint ventures or investments we may make.

You should read this report and the documents that we reference in this report and have filed as exhibits to this report completely and with the understanding that our actual future results may be materially different from what we expect. The forward-looking statements contained in this report are made as of the date of this report, and we do not assume, and specifically disclaim, any obligation to update any forward-looking statements, whether as a result of new information, future events or otherwise.

Item 1B. UNRESOLVED STAFF COMMENTS

None.

Item 2. PROPERTIES

Our corporate headquarters are located in Northborough, Massachusetts, where we occupy approximately 51,650 square feet under a lease expiring on December 31, 2026. We also own an approximately 143,000 square foot manufacturing facility in East Providence, Rhode Island. In addition, we lease a 10,500 square foot facility, a 24,000 square foot facility and a 128,000 square foot facility in East Providence, Rhode Island, which leases expire on March 31, 2021, March 31, 2021 and March 31, 2024, respectively.

Item 3. LEGAL PROCEEDINGS

Patent Enforcement Actions

In May 2016, we filed a complaint for patent infringement against Nano Tech Co., Ltd. (Nano), and Guangdong Alison Hi Tech., Ltd. (Alison) in the International Trade Commission, or ITC. In the ITC complaint, we alleged that these two China-based companies have engaged and are engaging in unfair trade practices by importing aerogel products in the United States that infringe, and/or are manufactured by processes that infringe, several of our patents in violation of Section 337 of the Tariff Act of 1930. In the ITC complaint, we sought exclusion orders from the ITC that direct the United States Customs and Border Protection to stop the importation of these infringing products. In February 2018, the ITC issued its final determination confirming the ALJ's previous initial determination that Nano and Alison had infringed asserted Aspen patents and that they have not proven the patents are invalid except with respect to one dependent product claim, which the ITC found was not infringed. The ITC affirmed that Alison and Nano each violated Section 337 of the Tariff Act and issued a limited exclusion order prohibiting importation of infringing aerogel insulation products manufactured by Alison and Nano. Alison unsuccessfully appealed the ITC determination with respect to a product patent to the United States Court of Appeals for the Federal Circuit (CAFC), which affirmed the validity of the Aspen patent. The exclusion order, which is enforced by the United States Customs and Border Protection, is currently in effect. Additionally, the United States Patent and Trademark Office, or USPTO, denied Alison's requests to invalidate the claims of four of the Aspen patents in Inter-Partes Review. Alison also filed multiple similar requests with the Chinese Patent Office, or SIPO, seeking to invalidate our Chinese manufacturing process patents and two of our Chinese product patents. With respect to one of those requests, not withdrawn previously by Alison, the Patent Reexamination Board of SIPO (PRB), issued a decision upholding the validity of Aspen's issued patent as amended in the proceedings. Alison has appealed the PRB's decision to the Beijing IP court. After the oral hearing at the Beijing IP court, we are awaiting the decision by the court. Nano has also filed a request seeking invalidation of a product patent at PRB of SIPO on which oral hearing took place in July 2019. After the oral hearing, Nano withdrew its invalidation request. On September 23, 2019, Alison filed yet another request to invalidate the same patent, whose prior validity opinion by PRB is currently on appeal at the Beijing IP Court. After conducting an oral hearing, PRB issued a decision on January 23, 2020 denying Alison's latest invalidation request of this patent.

In April 2016, we also filed a patent infringement suit at the District Court in Mannheim, Germany (Mannheim court), against Nano, Alison and two European resellers asserting their infringement of one of our German patents. We subsequently asserted infringement of another three patents against Nano, Alison and a European reseller of Alison's products at the Mannheim court. We have since settled with one European reseller in exchange for a commitment not to procure infringing products and cooperation with our case. In January 2018, the court issued a series of judgments by acknowledgement (German, "Anerkenntnisurteil") finding the second reseller, Hiltex, liable for infringement and also issued injunctions against Hiltex. The judgments resulted from a settlement agreement in which Hiltex agreed not to resell the infringing products in Europe where at least one of the asserted patents are active. Nano and Alison also initiated nullity actions in German Federal Patent Court in Munich against our asserted German patents.

On March 8, 2019, Mannheim court issued two separate judgments in cases against Nano and Alison, respectively. The Mannheim court determined that both Nano and Alison are infringing on Aspen's EP1638750 (750 Patent) in connection with their respective products. The court also issued injunctions prohibiting the offer, putting on the market, using, importing or possessing the infringing products. The court found the defendants liable to us for damages since September 22, 2012. The court also ordered the defendants to provide information on the scope of the acts of infringement committed since August 22, 2012, and a recall of infringing products. The court ordered Nano and Alison to bear the costs of the legal proceedings and reimburse statutory attorneys' costs and expenses to us, that exact amount of which is yet to be determined. Nano and Alison have appealed the judgements of the Mannheim court. The appeal is currently ongoing. The Federal Patent Court in Munich previously dismissed the challenge to the validity of 750 Patent which has become final.

Nano and Alison also filed an opposition to one of the asserted patents at the European Patent Office (EPO). In December 2018, the opposition division of EPO determined the patent, EP2813338 (338 Patent), was invalid on formality grounds and decided to revoke it, which determination is currently under appeal at the EPO Board of appeals. On March 19 and 20, 2019 the German Federal Patent Court in Munich conducted oral proceedings and voided four claims in EP2415577 (577 Patent) and confirmed the validity of challenged claims in EP2422950 (950 Patent) within the scope of silica gels. The Mannheim court issued two decisions on December 23, 2019 finding that Alison infringed 577 Patent and 950 Patent and also issued injunctions prohibiting Alison from continuing infringement in connection with any aerogel sheets. As of March 6, 2020, we are unaware of any timely appeal of these December 2019 decisions by Alison. Upon confirmation of the same by the Mannheim Court, we expect the decisions to become final. The infringement proceedings at the Mannheim court based on 577 Patent and 950 Patent are currently ongoing against Nano.

Additionally, a reseller of Nano's products in Taiwan challenged the validity of one of our patents in Taiwan in 2018. After careful review of our written response, the Taiwanese patent office has determined the patent as valid and dismissed the challenge in December 2018. In 2018, LG Chem Ltd. challenged the validity of one of our patents in Korea at the Intellectual Property Trial and Appeals Board (IPTAB) of the Korean Intellectual Property Office. After conducting an oral hearing, the IPTAB issued a decision on November 30, 2019 upholding claims related to aerogel sheets incorporating fibers and invalidating claims for aerogel sheets not incorporating fibers. The IPTAB decision is currently on appeal at the Korean Patent Court.

Due to their nature, it is difficult to predict the outcome or the costs involved in any litigation or administrative proceedings, including any appeals process. Furthermore, the counter parties in these proceedings may have significant resources and interest to litigate and therefore, these litigation matters could be protracted and may ultimately involve significant legal expenses. In addition to the foregoing, we have been and may be from time to time a party to other legal proceedings that arise in the ordinary course of business and to other patent enforcement actions to assert our patent rights.

Brazilian Enforcement Action

In August 2018, we filed an enforcement suit against Qualiman Engenharia E Montagens LTDA, or Qualiman, one of our South American customers, in civil court in Sao Paulo, Brazil seeking payment of past due invoices totaling approximately $2.9 million. In October 2018, the Brazilian court ruled in our favor with respect to Qualiman's obligation to pay us immediately. As part of the remedy, the Court ordered Qualiman's customer, Petroleo Brasilero S.A., or Petrobras, to redirect part of its payments to Qualiman to a court-administered bank account and other appropriate actions. Subsequently, we learned that Qualiman has laid off a substantial portion of its installers and threatened to walk away from Petrobras' contract. In connection with such layoffs, a Brazilian labor court is addressing reparations to laid-off workers. We learned that Petrobras and Qualiman are seeking to renegotiate the contract between them in connection with this project. On February 26, 2019, an appeals court dismissed Qualiman's appeal of the decision of the Sao Paulo civil court on the merits. Subsequent to this ruling, we recovered $0.3 million through these court actions. Additional recovery of remaining unpaid accounts receivable is unlikely due to Qualiman's filing of judicial reorganization under Brazilian laws and its consequences on our recovery action.

Item 4. MINE SAFETY DISCLOSURES

Not applicable.

PART II

Item 5. MARKET FOR REGISTRANT'S COMMON EQUITY, RELATED STOCKHOLDER MATTERS AND ISSUER PURCHASES OF EQUITY SECURITIES

Market Information and Dividend Policy

Our common stock is trading on The New York Stock Exchange, or NYSE, under the symbol "ASPN." As of March 5, 2020, there were approximately 92 stockholders of record of our common stock.

Dividends

We have not paid dividends to our stockholders since our inception and we do not plan to pay cash dividends in the foreseeable future. We currently intend to retain earnings, if any, to finance the development and expansion of our business.

Unregistered Sales of Equity Securities and Use of Proceeds

(a) *Unregistered Sales of Equity Securities*. Not applicable.

(b) *Use of Proceeds from Initial Public Offering of Common Stock*. Not applicable.

(c) *Purchases of Equity Securities By the Issuer and Affiliated Purchasers*. We did not repurchase any of our equity securities during the year ended December 31, 2019.

Item 6. SELECTED FINANCIAL DATA

The following table sets forth our selected consolidated financial data for the periods, and as of the dates, indicated. You should read the following selected consolidated financial data in conjunction with our consolidated financial statements and the related notes thereto included elsewhere in this Annual Report on Form 10-K and the "Management's Discussion and Analysis of Financial Condition and Results of Operations" section of this Annual Report on Form 10-K.

We derived the consolidated statement of operations data for the years ended December 31, 2019, 2018 and 2017, and the consolidated balance sheet data as of December 31, 2019 and 2018, from our audited consolidated financial statements and the related notes thereto included elsewhere in this Annual Report, which financial statements have been audited by KPMG LLP, independent registered public accounting firm. We derived the consolidated statement of operations data for the fiscal years ended December 31, 2016 and 2015, and the consolidated balance sheet data as of December 31, 2017, 2016 and 2015, from our audited consolidated financial statements and the related notes thereto that are not included in this Annual Report, which financial statements have been audited by KPMG LLP, independent registered public accounting firm.

	Year Ended December 31,				
	2019	2018	2017	2016	2015
	($ in thousands, except share and per share data)				
Consolidated statements of operations data:					
Revenue:					
Product	$ 136,934	$ 102,123	$ 109,590	$ 115,490	$ 120,532
Research services	2,441	2,238	2,041	2,248	1,986
Total revenue	139,375	104,361	111,631	117,738	122,518
Cost of revenue:					
Product	111,759	90,660	92,052	93,123	96,865
Research services	1,332	1,032	908	1,304	1,005
Gross profit	26,284	12,669	18,671	23,311	24,648
Operating expenses:					
Research and development	8,407	6,319	6,180	5,306	5,253
Sales and marketing	15,557	13,794	12,604	11,810	10,562
General and administrative	16,479	19,116	19,023	17,415	15,068
Impairment of construction in progress	—	7,356	—	—	—
Total operating expenses	40,443	46,585	37,807	34,531	30,883
Loss from operations	(14,159)	(33,916)	(19,136)	(11,220)	(6,235)
Other expense, net:					
Interest expense, net	(406)	(524)	(185)	(147)	(182)
Postponed financing costs	—	—	—	(656)	—
Total other expense, net	(406)	(524)	(185)	(803)	(182)
Net loss	(14,565)	(34,440)	(19,321)	(12,023)	(6,417)
Per share data:					
Net loss per share:					
Basic and diluted	$ (0.60)	$ (1.45)	$ (0.83)	$ (0.52)	$ (0.28)
Weighted-average common shares outstanding:					
Basic and diluted	24,099,438	23,738,852	23,390,235	23,139,807	22,986,931

	As of December 31,				
	2019	2018	2017	2016	2015
Consolidated balance sheet data:					
Cash and cash equivalents	$ 3,633	$ 3,327	$ 10,694	$ 18,086	$ 32,804
Working capital (1)	15,335	14,185	26,093	32,056	44,238
Total assets	103,502	99,023	123,815	134,669	140,074
Total debt	3,123	4,181	3,750	39	107
Total stockholders' equity	58,990	70,254	100,943	115,564	122,474

(1) Working capital means current assets minus current liabilities.

Item 7. MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS

The following discussion of our financial condition and results of operations should be read in conjunction with the "Selected Financial Data" and our consolidated financial statements and the related notes thereto included in this Annual Report on Form 10-K. In addition to historical information, some of the information contained in the following discussion and analysis or set forth elsewhere in this report, including information with respect to our plans and strategy for our business, includes forward looking information that involves risks, uncertainties and assumptions. You should read the Risk Factors set forth in Item 1A of this Annual Report on Form 10-K for a discussion of important factors that could cause actual results to differ materially from the results described in or implied by the forward-looking statements contained in the following discussion and analysis. Our actual results and the timing of events could differ materially from those anticipated by these forward looking statements.

Investors and others should note that we routinely use the Investors section of our website to announce material information to investors and the marketplace. While not all of the information that we post on the Investors section of our website is of a material nature, some information could be deemed to be material. Accordingly, we encourage investors, the media, and others interested in us to review the information that we share on the Investors section of our website, https://www.aerogel.com/.

Overview

We design, develop and manufacture innovative, high-performance aerogel insulation used primarily in the energy infrastructure and building materials markets. We believe our aerogel blankets deliver the best thermal performance of any widely used insulation product available on the market today and provide a combination of performance attributes unmatched by traditional insulation materials. Our end-use customers select our products where thermal performance is critical and to save money, improve resource efficiency, enhance sustainability, preserve operating assets and protect workers.

Our insulation is used by oil producers and the owners and operators of refineries, petrochemical plants, liquefied natural gas facilities, power generating assets and other energy infrastructure. Our Pyrogel and Cryogel product lines have undergone rigorous technical validation by industry leading end-users and achieved significant market adoption. We also derive product revenue from the building materials and other end markets. Customers in these markets use our products for applications as diverse as wall systems, military and commercial aircraft, trains, buses, appliances, apparel, footwear and outdoor gear. As we continue to enhance our aerogel technology platform, we believe we will have opportunities to address additional high value applications in the global insulation market and in a diverse set of new markets, including the electric vehicle market.

We generate product revenue through the sale of our line of aerogel blankets. We market and sell our products primarily through a sales force based in North America, Europe and Asia. The efforts of our sales force are supported by a small number of sales consultants with extensive knowledge of a particular market or region. Our sales force is responsible for establishing and maintaining customer and partner relationships, delivering highly technical information and ensuring high-quality customer service.

Our salespeople work directly with end-use customers and engineering firms to promote the qualification, specification and acceptance of our products. We also rely on an existing and well-established channel of qualified insulation distributors and contractors in more than 50 countries around the world to ensure rapid delivery of our products and strong end-user support. Our salespeople also work to educate insulation contractors about the technical and operating cost advantages of our aerogel blankets.

We also perform research services under contracts with various agencies of the U.S. government, including the Department of Defense and the Department of Energy, and other institutions. Research performed under contract with government agencies and other institutions enables us to develop and leverage technologies into broader commercial applications. In late 2019, we decided to cease efforts to secure additional funded research contracts and to wind down our existing contract research activities during 2020. This decision reflected our desire to focus our research and development resources on initiatives to improve the profitability of our existing business and on efforts to develop new products and next generation technology with application in new, high value market segments.

We manufacture our products using our proprietary technology at our facility in East Providence, Rhode Island. We have operated the East Providence facility since 2008 and had increased our annual capacity through 2017 to 50 million square feet of aerogel blankets. During 2018, we initiated a series of projects designed to increase this capacity to 60 million square feet of aerogel blankets by the end of 2020. As of December 31, 2019, we had increased our annual capacity to 55 million square feet of aerogel blankets as a result of this initiative.

We had previously completed the design and engineering for a second manufacturing facility to be located in Statesboro, Georgia. During 2016, we elected to delay construction of the facility due to our assessment of future demand. In December 2018, we determined that we will not use the existing design and engineering to construct a second facility in any location. Accordingly, we determined that the design and engineering costs were not recoverable and recorded an impairment charge of $7.4 million on construction in progress assets during 2018.

We are engaged in a strategic partnership with BASF to develop and commercialize products for the building materials and other markets. The strategic partnership includes a supply agreement governing the exclusive sale of specified products to BASF and a joint development agreement targeting innovative products and technologies. BASF has no obligation to purchase any products under the supply agreement. Pursuant to the supply agreement, BASF may, in its sole discretion, make prepayments to us in the aggregate amount of up to $22.0 million during the term of the agreement. We may repay the prepayments to BASF at any time in whole or in part for any reason.

BASF made a prepayment to us of $5.0 million during 2018. As of January 1, 2019, 25.3% of any amounts that we invoice for Spaceloft A2 sold to BASF will be credited against the outstanding balance of the 2018 prepayment. If any amount of the 2018 prepayment remains uncredited at December 31, 2021, BASF may require that we repay the uncredited amount to BASF. In January 2019, BASF made an additional prepayment to us of $5.0 million. After January 1, 2020, 50% of any amounts that we invoice for a newly developed product sold to BASF will be credited against the outstanding balance of the 2019 prepayment. After December 31, 2022, BASF may require that we credit 24.7% of any amounts we invoice for Spaceloft A2 sold to BASF against the outstanding balance of the 2019 prepayment or may require that we repay the uncredited amount to BASF.

On February 18, 2020, we completed an underwritten public offering of 1,955,000 shares of our common stock at an offering price of $8.25 per share. We received net proceeds of $14.8 million after deducting underwriting discounts of $1.0 million and offering expenses of approximately $0.4 million.

On March 3, 2020, we amended our revolving credit facility with Silicon Valley Bank to extend the maturity date of the facility to April 28, 2021. Under our revolving credit facility, we are permitted to borrow a maximum of $20.0 million, subject to continued covenant compliance and borrowing base requirements. At our election, the interest rate applicable to borrowings under the revolving credit facility may be based on the prime rate or LIBOR. Prime rate-based rates vary from prime rate plus 0.75% per annum to prime rate plus 2.00% per annum, while LIBOR-based rates vary from LIBOR plus 3.75% per annum to LIBOR plus 4.25% per annum. In addition, we are required to pay a monthly unused revolving line facility fee of 0.5% per annum of the average unused portion of the revolving credit facility. The credit facility has also been amended to establish certain minimum Adjusted EBITDA levels with respect to the minimum Adjusted EBITDA financial covenant for the extended term. We intend to extend or replace the facility prior to its maturity.

Our revenue for the year ended December 31, 2019 was $139.4 million, which represented an increase of $35.0 million, or 34%, from the year ended December 31, 2018. Net loss for the year ended December 31, 2019 was $14.6 million and net loss per share was $0.60. Net loss for the year ended December 31, 2018 was $34.4 million and net loss per share was $1.45.

Key Metrics and Non-GAAP Financial Measures

We regularly review a number of metrics, including the following key metrics, to evaluate our business, measure our performance, identify trends affecting our business, formulate financial projections and make strategic decisions.

Square Foot Operating Metric

We price our product and measure our product shipments in square feet. We estimate our annual capacity was 55 million square feet of aerogel blankets at December 31, 2019. We believe the square foot operating metric allows us and our investors to measure our manufacturing capacity and product shipments on a uniform and consistent basis. The following chart sets forth product shipments in square feet associated with recognized revenue, including revenue recognized over time utilizing the input/cost-to-cost method, for the periods presented:

	Year Ended December 31,		
	2019	**2018**	**2017**
		(Square feet in thousands)	
Product shipments in square feet	40,720	34,435	37,519

Adjusted EBITDA

We use Adjusted EBITDA, a non-GAAP financial measure, as a means to assess our operating performance. We define Adjusted EBITDA as net income (loss) before interest expense, taxes, depreciation, amortization, stock-based compensation expense and other items, from time to time, which we do not believe are indicative of our core operating performance, which in 2018 included an impairment of construction in progress. Adjusted EBITDA is a supplemental measure of our performance that is not presented in accordance with U.S. GAAP. Adjusted EBITDA should not be considered as an alternative to net income (loss) or any other measure of financial performance calculated and presented in accordance with U.S. GAAP. In addition, our definition and presentation of Adjusted EBITDA may not be comparable to similarly titled measures presented by other companies.

We use Adjusted EBITDA:

- as a measure of operating performance because it does not include the impact of items that we do not consider indicative of our core operating performance;
- for planning purposes, including the preparation of our annual operating budget;
- to allocate resources to enhance the financial performance of our business; and
- as a performance measure used under our bonus plan.

We also believe that the presentation of Adjusted EBITDA provides useful information to investors with respect to our results of operations and in assessing the performance and value of our business. Various measures of EBITDA are widely used by investors to measure a company’s operating performance without regard to items that can vary substantially from company to company depending upon financing and accounting methods, book values of assets, capital structures and the methods by which assets were acquired.

Although measures similar to Adjusted EBITDA are frequently used by investors and securities analysts in their evaluation of companies, we understand that Adjusted EBITDA has limitations as an analytical tool, and you should not consider it in isolation or as a substitute for net income, income from operations, net cash provided by (used in) operating activities or an analysis of our results of operations as reported under U.S. GAAP. Some of these limitations are:

- Adjusted EBITDA does not reflect our historical cash expenditures or future requirements for capital expenditures or other contractual commitments;
- Adjusted EBITDA does not reflect changes in, or cash requirements for, our working capital needs;
- Adjusted EBITDA does not reflect stock-based compensation expense;
- Adjusted EBITDA does not reflect our tax expense or cash requirements to pay our income taxes;
- Adjusted EBITDA does not reflect our interest expense, or the cash requirements necessary to service interest or principal payments on our debt;
- although depreciation, amortization and impairment charges are non-cash charges, the assets being depreciated, amortized or impaired will often have to be replaced in the future, and Adjusted EBITDA does not reflect any cash requirements for these replacements; and
- other companies in our industry may calculate EBITDA or Adjusted EBITDA differently than we do, limiting their usefulness as a comparative measure.

Because of these limitations, our Adjusted EBITDA should not be considered as a measure of discretionary cash available to us to reinvest in the growth of our business or as a measure of cash available for us to meet our obligations.

To properly and prudently evaluate our business, we encourage you to review the GAAP financial statements included elsewhere in this Annual Report on Form 10-K, and not to rely on any single financial measure to evaluate our business.

The following table presents a reconciliation of net loss, the most directly comparable GAAP measure, to Adjusted EBITDA for the years presented:

	Year Ended December 31,		
	2019	2018	2017
	($ in thousands)		
Net loss	$ (14,565)	$ (34,440)	$ (19,321)
Depreciation and amortization	10,213	10,787	10,753
Impairment of construction in progress	—	7,356	—
Stock-based compensation (1)	3,771	4,302	5,091
Interest expense, net	406	524	185
Adjusted EBITDA	$ (175)	$ (11,471)	$ (3,292)

(1) Represents non-cash stock-based compensation related to vesting and modifications of stock option grants, vesting of restricted stock units and vesting and modification of restricted common stock.

The following table presents a reconciliation of net loss, the most directly comparable GAAP measure, to Adjusted EBITDA for the quarters presented:

	Three months ended 2019				Three months ended 2018			
	March 31	June 30	Sept. 30	Dec. 31	March 31	June 30	Sept. 30	Dec. 31
	($ in thousands)							
Net loss	$ (6,002)	$ (5,318)	$ (2,289)	$ (956)	$ (6,842)	$ (6,958)	$ (6,532)	$ (14,108)
Depreciation and amortization	2,532	2,565	2,554	2,562	3,171	2,515	2,573	2,528
Impairment of construction in progress	—	—	—	—	—	—	—	7,356
Stock-based compensation (1)	878	996	1,011	886	1,136	1,150	1,128	888
Interest expense, net	41	103	136	126	92	103	163	166
Adjusted EBITDA	$ (2,551)	$ (1,654)	$ 1,412	$ 2,618	$ (2,443)	$ (3,190)	$ (2,668)	$ (3,170)

(1) Represents non-cash stock-based compensation related to vesting and modifications of stock option grants, vesting of restricted stock units and vesting and modification of restricted common stock.

Our financial performance, including such measures as net income (loss), earnings per share and Adjusted EBITDA, are affected by a number of factors including volume and mix of aerogel products sold, average selling prices, our material and manufacturing costs, the costs associated with capacity expansions and start-up of additional production capacity, and the amount and timing of operating expenses, including patent enforcement costs. Accordingly, we expect that our net income (loss), earnings per share and Adjusted EBITDA will vary from period to period.

During 2019, we experienced volume growth in our core petrochemical and refinery markets in North America, and an increase in project-based demand, particularly in the subsea and LNG markets. We also implemented a price increase for 2019 designed to support revenue growth and to offset an increase in raw material costs. As a result of these factors, we achieved total revenue growth of 34%, a decrease in net loss, and an improvement in Adjusted EBITDA during 2019 versus 2018.

During 2020, we expect our revenue growth rate to moderate principally due to an anticipated decrease in project-based demand in the subsea market and our expectation of little to no growth in project-based demand in the LNG market. In addition, we have decided to wind down our contract research activities in 2020 to focus our research and development resources on initiatives to improve the profitability of our existing business and to leverage our aerogel technology into new markets, including the electric vehicle market. Despite the lower projected growth rate, we expect that our ongoing initiatives to reduce raw material costs will help to increase our gross profit and to expand our gross margin. As a result, we are a projecting strong year-over-year improvements in both net loss and Adjusted EBITDA in 2020.

Components of Our Results of Operations

Revenue

We recognize product revenue from the sale of our line of aerogel products and research services revenue from the provision of services under contracts with various agencies of the U.S. government and other institutions. Product and research services revenue is recognized upon the satisfaction of contractual performance obligations.

We record deferred revenue for product sales when (i) we have delivered products but other revenue recognition criteria have not been satisfied or (ii) payments have been received in advance of the completion of required performance obligations.

The following table sets forth the total revenue for the periods presented:

	Year Ended December 31, 2019	2018	2017
	($ in thousands)		
Revenue:			
Product	$ 136,934	$ 102,123	$ 109,590
Research services	2,441	2,238	2,041
Total revenue	$ 139,375	$ 104,361	$ 111,631

Product revenue accounted for 98% of total revenue for each of the years ended December 31, 2019, 2018 and 2017. We experienced a 34% increase in total revenue during 2019 principally due to growth in the North American petrochemical and refinery market, an increase in project based demand in the LNG and subsea markets, and the impact of price increases enacted in early 2019, offset, in part, by decreases in shipments to the building materials and Asian petrochemical markets.

During 2020, we expect our revenue growth to moderate principally due to an anticipated decrease in project-based demand in the subsea market. We also expect to see little to no growth in project-based demand in the LNG market. In addition, we have decided to wind down our research services activities in 2020 in order to focus our research and development resources on initiatives to improve the profitability of our existing business and to leverage our aerogel technology into new markets, including the electric vehicle market. As a result, we expect that research services revenue will decrease as a percentage of total revenue during 2020.

A substantial majority of our revenue is generated from a limited number of direct customers, including distributors, contractors, OEMs, partners and end-use customers. Our 10 largest customers accounted for approximately 68% of our total revenue during the year ended December 31, 2019, and we expect that most of our revenue will continue to come from a relatively small number of customers for the foreseeable future. In 2019, sales to Distribution International, Inc. and SPCC Joint Venture represented 20% and 13% our total revenue, respectively. In 2018, sales to Distribution International, Inc. represented 20% of our total revenue. In 2017, sales to Distribution International Inc. and TechnipFMC represented 15% and 12% of our total revenue, respectively. For each of the noted periods, there were no other customers that represented 10% or more of our total revenues.

We conduct business across the globe and a substantial portion of our revenue is generated outside of the United States. Total revenue from outside of the United States, based on shipment destination, amounted to $81.0 million, or 58% of our total revenue, $62.6 million, or 60% of our total revenue, and $60.2 million, or 54% of our total revenue, in the years ended December 31, 2019, 2018 and 2017, respectively.

Cost of Revenue

Cost of product revenue consists primarily of materials and manufacturing expense. Cost of product revenue is recorded when the related product revenue is recognized.

Material is our most significant component of cost of product revenue and includes fibrous batting, silica materials and additives. Material costs as a percentage of product revenue were 48%, 47% and 45% for the years ended December 31, 2019, 2018 and 2017, respectively. Material costs as a percentage of product revenue vary from product to product due to differences in average selling prices, material requirements, product thicknesses and manufacturing yields. In addition, we provide warranties for our products and record the estimated cost within cost of revenue in the period that the related revenue is recorded or when we become aware that a potential warranty claim is probable and can be reasonably estimated. As a result of these factors, material costs as a percentage of product revenue will vary from period to period due to changes in the mix of aerogel products sold, the costs of our raw materials or the estimated cost of warranties.

During the year ended December 31, 2018, we experienced a significant increase in the costs of certain silica precursor materials, which constitute over 50% of our raw material costs. In response, we are seeking to achieve higher selling prices, lower cost formulations, material sourcing improvements, and manufacturing yield enhancements to reduce the cost of raw materials for our aerogel products. We expect that material costs will decrease both in absolute dollars and as a percentage of product revenue during 2020 as we focus our research and development resources on improving the profitability of our existing business principally through implementation of lower cost product formulations.

Manufacturing expense is also a significant component of cost of product revenue. Manufacturing expense includes labor, utilities, maintenance expense, and depreciation on manufacturing assets. Manufacturing expense also includes stock-based compensation of manufacturing employees and shipping costs. Manufacturing expense as a percentage of product revenue was 33%, 42% and 39% for the years ended December 31, 2019, 2018 and 2017, respectively. While product revenue increased by 34% during 2019, manufacturing expense increased by only 7% due principally to the high proportion of fixed manufacturing expense in our East Providence, Rhode Island manufacturing facility. We expect that manufacturing expense will grow both in absolute dollars and as a percentage of product revenue during 2020 principally due to increases in compensation and related costs, product qualification expenses, and waste disposal expenses, offset, in part, by decreases in process gas and utilities expenses.

In total, we expect that cost of product revenue will decrease both in absolute dollars and as a percentage of product revenue during 2020 versus 2019. In the longer term, we expect cost of product revenue will increase in absolute dollars but continue to decline as a percentage of product revenue.

Cost of research services revenue consists of direct labor costs of research personnel engaged in the contract research, third-party consulting and subcontractor expense, and associated direct material costs. This cost of revenue also includes overhead expenses associated with project resources, development tools and supplies. Cost of research services revenue is recorded when the related research services revenue is recognized. We expect cost of research services will decline as we wind down our existing contract research activities during 2020.

Gross Profit

Our gross profit as a percentage of revenue is affected by a number of factors, including the volume of aerogel products produced and sold, the mix of aerogel products sold, average selling prices, our material and manufacturing costs, realized capacity utilization and the costs associated with expansions and start-up of production capacity. Accordingly, we expect our gross profit in absolute dollars and as a percentage of revenue to vary significantly from period to period.

During 2019, we experienced growth in revenue as a result of volume growth in our core petrochemical and refinery markets in the United States, and an increase in project-based demand, particularly in the subsea and LNG markets. We also implemented a price increase for 2019 designed to offset recent increases in raw material costs and to improve gross profit margins. In addition, manufacturing expenses grew during 2019 at a rate significantly lower than growth in product revenue due to the high proportion of fixed manufacturing expense in our manufacturing operations. As a result, gross profit improved both in absolute dollars and as a percentage of revenue during the year.

During 2020, we expect our revenue growth rate to moderate principally due to an anticipated decrease in project-based demand in the subsea market and our expectation of little to no growth in project-based demand in the LNG market. In addition, we have decided to wind down our contract research activities in 2020 in order to focus our research and development resources on initiatives to improve the profitability of our existing business and to leverage our aerogel technology into new markets. Despite the lower projected growth rate, we expect that our ongoing initiatives to reduce raw material costs will help to increase our gross profit and to expand our gross margin. Accordingly, we expect gross profit to improve both in absolute dollars and as a percentage of revenue during 2020.

In the longer term, we expect gross profit to continue to improve in absolute dollars and as a percentage of revenue due to expected increases in total revenue, production volumes and manufacturing productivity. In addition, we expect the gross profit improvement derived from the increases in revenue, volume and productivity will be supported by the continued implementation of lower cost product formulations and realization of material purchasing efficiencies.

Operating Expenses

Operating expenses consist of research and development, sales and marketing, and general and administrative expenses. Operating expenses include personnel costs, legal fees, professional fees, service fees, insurance premiums, travel expense, facilities related costs and other costs and fees. The largest component of our operating expenses is personnel costs, consisting of salaries, benefits, incentive compensation and stock-based compensation. In any particular period, the timing and extent of personnel additions or reductions, legal activities, including patent enforcement actions, marketing programs, research efforts and a range of similar activities or actions could materially affect our operating expenses, both in absolute dollars and as a percentage of revenue.

During 2020, we project operating expenses to increase in both absolute dollars and as a percentage of revenue. In the longer term, we expect that operating expenses will increase in absolute dollars, but decrease as a percentage of revenue.

Research and Development Expenses

Research and development expenses consist primarily of expenses for personnel engaged in the development of next generation aerogel compositions, form factors and manufacturing technologies. These expenses also include testing services, prototype expenses, consulting services, trial formulations for new products, equipment depreciation, facilities costs and related overhead. We expense research and development costs as incurred. We expect to continue to devote substantial resources to the development of new aerogel technologies. We believe that these investments are necessary to maintain and improve our competitive position. We expect to continue to invest in research and engineering personnel and the infrastructure required in support of their efforts. While we expect that our research and development expenses will increase in absolute dollars but decrease as a percentage of revenue in the longer term, in 2020 we expect such expenses will increase in both absolute dollars and as a percentage of revenue.

Sales and Marketing Expenses

Sales and marketing expenses consist primarily of personnel costs, incentive compensation, marketing programs, travel and related costs, consulting expenses and facilities related costs. We have expanded our sales force and sales consultants globally to drive anticipated growth in customers and demand for our products. While we expect that our sales and marketing expenses will increase in absolute dollars but decrease as a percentage of revenue in the longer term, in 2020 we expect such expenses will increase in both absolute dollars and as a percentage of revenue.

General and Administrative Expenses

General and administrative expenses consist primarily of personnel costs, legal expenses, consulting and professional services, audit and tax consulting costs, and expenses for our executive, finance, legal, human resources and information technology organizations. General and administrative expenses have increased as we have incurred additional costs related to operating as a publicly-traded company, which include costs of compliance with securities, corporate governance and related laws and regulations, investor relations expenses, increased insurance premiums, including director and officer insurance, and increased audit and legal fees. In addition, we expect our general and administrative expenses to increase as we add general and administrative personnel to support the anticipated growth of our business. We also expect that the patent enforcement actions, described in more detail under "Legal Proceedings" in Part I, Item 3 of this Annual Report on Form 10-K, if protracted, could result in significant legal expense over the medium to long-term. While we expect that our general and administrative expenses will increase in absolute dollars but decrease as a percentage of revenue in the longer term, in 2020 we expect such expenses will increase in both absolute dollars and as a percentage of revenue.

Interest Expense, Net

For the years ended December 31, 2019, 2018, and 2017, interest expense, net consisted primarily of fees and interest expense related to our revolving credit facility.

Provision for Income Taxes

We have incurred net losses since inception and have not recorded benefit provisions for U.S. federal income taxes or state income taxes since the tax benefits of our net losses have been offset by valuation allowances due to the uncertainty associated with the utilization of net operating loss carryforwards.

At December 31, 2019, the Company had $233.8 million of net operating losses available to offset future federal income, if any, of which $194.6 million expire on various dates through December 31, 2037. Net operating losses of $39.2 million generated during the years ended December 31, 2019 and 2018 have an unlimited carryforward.

On December 22, 2017, the President of the United States signed into law the Tax Cuts and Jobs Act (TCJA) tax reform legislation. This legislation makes significant change in U.S. tax law including a reduction in the corporate tax rates, changes to net operating loss carryforwards and carrybacks, and a repeal of the corporate alternative minimum tax. The legislation reduced the U.S. corporate tax rate from 34% to 21% for the years ending December 31, 2019 and 2018. As a result of the enacted law, we were required to revalue deferred tax assets and liabilities at the 21% rate as of December 31, 2017. This resulted in a decrease in our net deferred tax asset and corresponding valuation allowance of $26.7 million. As we maintain a full valuation allowance against our net deferred tax asset position in the United States, this revaluation did not result in an income tax expense or benefit in the prior year. The provisions of the TCJA related to the one-time mandatory transition tax on deemed repatriation did not have an impact on our results of operations during the year ended December 31, 2017. The other provisions of the TCJA did not have a material impact on our 2019, 2018, and 2017 consolidated financial statements.

Results of Operations

The following tables set forth our results of operations for the periods presented:

	Year Ended December 31,		
	2019	2018	2017
	($ in thousands)		
Revenue:			
Product	$ 136,934	$ 102,123	$ 109,590
Research services	2,441	2,238	2,041
Total revenue	139,375	104,361	111,631
Cost of revenue:			
Product	111,759	90,660	92,052
Research services	1,332	1,032	908
Gross profit	26,284	12,669	18,671
Operating expenses:			
Research and development	8,407	6,319	6,180
Sales and marketing	15,557	13,794	12,604
General and administrative	16,479	19,116	19,023
Impairment of construction in progress	—	7,356	—
Total operating expenses	40,443	46,585	37,807
Loss from operations	(14,159)	(33,916)	(19,136)
Interest expense, net	(406)	(524)	(185)
Total interest expense, net	(406)	(524)	(185)
Net loss	$ (14,565)	$ (34,440)	$ (19,321)

Year ended December 31, 2019 compared to year ended December 31, 2018

The following tables set forth our results of operations for the periods presented:

	Year Ended December 31, 2019	Year Ended December 31, 2018	$ Change	% Change	Year Ended December 31, 2019	Year Ended December 31, 2018
	($ in thousands)				(Percentage of total revenue)	
Revenue:						
Product	$ 136,934	$ 102,123	$ 34,811	34%	98%	98%
Research services	2,441	2,238	203	9%	2%	2%
Total revenue	139,375	104,361	35,014	34%	100%	100%
Cost of revenue:						
Product	111,759	90,660	21,099	23%	80%	87%
Research services	1,332	1,032	300	29%	1%	1%
Gross profit	26,284	12,669	13,615	107%	19%	12%
Operating expenses:						
Research and development	8,407	6,319	2,088	33%	6%	6%
Sales and marketing	15,557	13,794	1,763	13%	11%	13%
General and administrative	16,479	19,116	(2,637)	(14)%	12%	18%
Impairment of construction in progress	—	7,356	(7,356)	100%	—%	7%
Total operating expenses	40,443	46,585	(6,142)	(13)%	29%	45%
Loss from operations	(14,159)	(33,916)	19,757	(58)%	(10)%	(32)%
Interest expense, net	(406)	(524)	118	(23)%	(0)%	(1)%
Total interest expense, net	(406)	(524)	118	(23)%	(0)%	(1)%
Net loss	$ (14,565)	$ (34,440)	$ 19,875	(58)%	(10)%	(33)%

Revenue

	Year Ended December 31, 2019 Amount	2019 Percentage of Revenue	2018 Amount	2018 Percentage of Revenue	Change Amount	Change Percentage
	($ in thousands)					
Revenue:						
Product	$ 136,934	98%	$ 102,123	98%	$ 34,811	34%
Research services	2,441	2%	2,238	2%	203	9%
Total revenue	$ 139,375	100%	$ 104,361	100%	$ 35,014	34%

The following chart sets forth product shipments in square feet associated with recognized revenue, including revenue recognized over time utilizing the input/cost-to-cost method, for the periods presented:

	Year Ended December 31, 2019	Year Ended December 31, 2018	Change Amount	Change Percentage
Product shipments in square feet (in thousands)	40,720	34,435	6,285	18%

Total revenue increased $35.0 million, or 34%, to $139.4 million in 2019 from $104.4 million in 2018 primarily as a result of an increase in product revenue.

Product revenue increased by $34.8 million, or 34%, to $136.9 million in 2019 from $102.1 million in 2018. This increase was principally the result of growth in the North American petrochemical and refinery markets, an increase in project-based demand in the LNG and subsea markets, and the impact of price increases enacted in early 2019, offset, in part, by decreases in shipments to the building materials and Asian petrochemical markets.

Product revenue for the year ended December 31, 2019 included $27.3 million in sales to Distribution International, Inc. and $18.0 million in sales to SPCC Joint Venture. Product revenue for the year ended December 31, 2018 included $21.4 million in sales to Distribution International, Inc.

The average selling price per square foot of our products increased by $0.40, or 14%, to $3.36 per square foot for the year ended December 31, 2019 from $2.96 per square foot for the year ended December 31, 2018. The increase in average selling price principally reflected the impact of price increases enacted in early 2019. This increase in average selling price had the effect of increasing product revenue by approximately $16.2 million for the year ended December 31, 2019.

In volume terms, product shipments increased by 6.3 million square feet, or 18%, to 40.7 million square feet of aerogel products for the year ended December 31, 2019, as compared to 34.4 million square feet in the year ended December 31, 2018. The increase in product volume had the effect of increasing product revenue by approximately $18.6 million for the year ended December 31, 2019.

Research services revenue increased by $0.2 million, or 9%, to $2.4 million in 2019 from $2.2 million in 2018. The increase was primarily due to the timing and amount of funding available under research contracts during the year ended December 31, 2019 from the comparable period in 2018.

Product revenue as a percentage of total revenue was 98% of total revenue in both 2019 and 2018. Research services revenue was 2% of total revenue in both 2019 and 2018. We expect that product revenue will comprise virtually all of our total revenue in the long-term.

During 2020, we anticipate our revenue growth to moderate principally due to an anticipated decrease in project-based demand in the subsea market. We also expect to see little to no growth in project-based demand in the LNG market. In addition, we have decided to wind down our research services activities in 2020 in order to focus our research and development resources on improving the profitability of our existing business and to leverage our aerogel technology into new markets, including the electric vehicle market.

Cost of Revenue

	Year Ended December 31,						Change	
	2019			2018				
	Amount	Percentage of Related Revenue	Percentage of Total Revenue	Amount	Percentage of Related Revenue	Percentage of Total Revenue	Amount	Percentage
	($ in thousands)							
Cost of revenue:								
Product	$ 111,759	82%	80%	$ 90,660	89%	87%	$ 21,099	23%
Research services	1,332	55%	1%	1,032	46%	1%	300	29%
Total cost of revenue	$ 113,091	81%	81%	$ 91,692	88%	88%	$ 21,399	23%

Total cost of revenue increased $21.4 million, or 23%, to $113.1 million in 2019 from $91.7 million in 2018. The increase in total cost of revenue was primarily the result of an increase in product cost of revenue.

Product cost of revenue increased $21.1 million, or 23%, to $111.8 million in 2019 from $90.7 million in 2018. The $21.1 million increase was the result of an $18.3 million increase in material costs and a $2.8 million increase in manufacturing expense. The increase in material costs was driven principally by the 6.3 million square feet, or 18%, increase in product shipments and an unfavorable mix of products sold. The increase in manufacturing expense was the result of increases in compensation and related costs of $1.7 million, waste disposal expense of $0.7 million and other manufacturing expenses of $0.4 million.

Product cost of revenue as a percentage of product revenue decreased to 82% in 2019 from 89% in 2018. This decrease was the result of the high proportion of fixed manufacturing expenses that remained essentially unchanged despite the 34% increase in product revenue in 2019, offset, in part, by the increase in material costs during the year.

We expect that product cost of revenue will decrease both in absolute dollars and as a percentage of product revenue during 2020 versus 2019 principally through implementation of lower cost product formulations and material purchasing efficiencies.

Research services cost of revenue increased by $0.3 million, or 29%, to $1.3 million in 2019 from $1.0 million in 2018. Cost of research service revenue as a percentage of research services revenue increased to 55% in 2019 from 46% in 2018 due to an increase in the proportion of third-party contract services utilized to support the contracted research.

Gross Profit

	Year Ended December 31,				Change	
	2019		2018			
	Amount	Percentage of Revenue	Amount	Percentage of Revenue	Amount	Percentage
	($ in thousands)					
Gross profit	$ 26,284	19%	$ 12,669	12%	$ 13,615	107%

Gross profit increased $13.6 million, or 107%, to $26.3 million in 2019 from $12.7 million in 2018. The increase in gross profit was the result of the $35.0 million increase in total revenue, offset, in part, by the $21.4 million increase in total cost of revenue. The increase in revenue was principally associated with growth in the North American petrochemical and refinery markets, an increase in project based demand in the LNG and subsea markets, and the impact of price increases enacted in early 2019, offset, in part, by a decrease in shipments to the building materials and Asian petrochemical markets. The increase in total cost of revenue was driven principally by the 6.3 million square feet, or 18%, increase in product shipments and the unfavorable mix of products sold.

Gross profit as a percentage of total revenue increased to 19% of total revenue in 2019 from 12% in 2018. This increase was principally the result of the high proportion of fixed manufacturing expenses that remained essentially unchanged despite the 34% increase in product revenue in 2019.

During 2020, we are projecting our revenue growth rate to moderate due to an anticipated decrease in project-based demand in the subsea market. We also expect to see little to no growth in project-based demand in the LNG market. In addition, we have decided to wind down our research services activities in 2020 in order to focus our research and development resources on improving the profitability of our existing business. Despite the lower projected growth rate, we expect that our ongoing initiatives to reduce raw material costs will help to increase our gross profit and to expand our gross margin. Accordingly, we expect gross profit to improve both in absolute dollars and as a percentage of revenue during 2020.

Research and Development Expenses

	Year Ended December 31,				Change	
	2019		2018			
	Amount	Percentage of Revenue	Amount	Percentage of Revenue	Amount	Percentage
	($ in thousands)					
Research and development expenses	$ 8,407	6%	$ 6,319	6%	$ 2,088	33%

Research and development expenses increased by $2.1 million, or 33%, to $8.4 million in 2019 from $6.3 million in 2018. The $2.1 million increase was the result of increases in compensation and related costs of $1.7 million and other research and development costs of $0.4 million.

Research and development expenses as a percentage of total revenue remained unchanged at 6% during the year ended December 31, 2019 from the comparable period in 2018.

We expect that our research and development expenses to increase in both absolute dollars and as a percentage of revenue during 2020 in support of the development of innovative products, advanced process technologies, and new markets.

In the long-term, we expect to continue to increase investment in research and development in our efforts to enhance and expand our aerogel technology platform. However, we expect that research and development expenses will decline as a percentage of total revenue in the long-term due to projected growth in product revenue.

Sales and Marketing Expenses

	Year Ended December 31,				Change	
	2019		2018			
	Amount	Percentage of Revenue	Amount	Percentage of Revenue	Amount	Percentage
	($ in thousands)					
Sales and marketing expenses	$ 15,557	11%	$ 13,794	13%	$ 1,763	13%

Sales and marketing expenses increased by $1.8 million, or 13%, to $15.6 million in 2019 from $13.8 million in 2018. The increase was the result of an increase in compensation and related costs of $1.6 million and professional fees of $0.6 million, offset, in part, by a decrease in marketing expenses of $0.4 million.

Sales and marketing expenses as a percentage of total revenue decreased to 11% in 2019 from 13% in 2018 due to the 34% increase in revenue, offset, in part, by the 13% increase in sales and marketing expenses in 2019.

We expect sales and marketing expenses to increase in both absolute dollars and as a percentage of revenue during 2020 due principally to a planned increase in marketing expense during the year.

In the long-term, we expect that sales and marketing expenses will increase in absolute dollars as we continue to increase sales personnel and marketing efforts in support of expected growth in demand for our products. However, we expect that sales and marketing expenses will decrease as a percentage of total revenue in the long-term due to projected growth in product revenue.

General and Administrative Expenses

	Year Ended December 31,				Change	
	2019		2018			
	Amount	Percentage of Revenue	Amount	Percentage of Revenue	Amount	Percentage
	($ in thousands)					
General and administrative expenses	$ 16,479	12%	$ 19,116	18%	$ (2,637)	(14)%

General and administrative expenses decreased by $2.6 million, or 14%, to $16.5 million in 2019 from $19.1 million in 2018. The $2.6 million decrease was the result of decreases in provision for uncollectible accounts of $3.1 million, professional fees of $0.4 million, and other general administrative expenses of $0.1 million, offset, in part, by increases in compensation and related costs of $0.9 million and patent enforcement costs of $0.1 million.

General and administrative expenses as a percentage of total revenue decreased to 12% in 2019 from 18% in 2018 due to both the 14% decrease in general and administrative expenses and the 34% increase in revenue in 2019.

We expect general and administrative expenses to increase in both absolute dollars and as a percentage of revenue during 2020.

We expect to increase general and administrative personnel and expense levels in the long term to support the anticipated growth of our business and continued expansion of our manufacturing operations. We also expect that the patent enforcement actions, described in more detail under “Legal Proceedings” in part I, Item 3, of this Annual Report on Form 10-K, will continue to result in high levels of legal expense in the near term and, if such actions are protracted, could result in significant additional legal expense over the medium to long term. In the longer term, we expect that general and administrative expenses will increase in absolute dollars but decrease as a percentage of revenue due to projected growth in product revenue.

Impairment of Construction In Progress

We had previously completed the design and engineering for a second manufacturing facility to be located in Statesboro, Georgia. During 2016, we elected to delay construction of the facility due to our assessment of future demand. In December 2018, we determined that we will not use the existing design and engineering to construct a second facility in any location. Accordingly, we determined that the design and engineering costs were not recoverable and recorded an impairment charge of $7.4 million on construction in progress assets in 2018. We did not record any impairments of construction in progress in 2019.

Interest Expense, Net

	Year Ended December 31,				Change	
	2019		2018			
	Amount	Percentage of Revenue	Amount	Percentage of Revenue	Amount	Percentage
	($ in thousands)					
Interest expense, net	$ (406)	(0)%	$ (524)	(1)%	$ 118	(23)%

Interest expense, net, consisting primarily of fees and interest expense associated with outstanding balances under our revolving credit agreement, was $0.4 million and $0.5 million in 2019 and 2018, respectively.

Year ended December 31, 2018 compared to year ended December 31, 2017

The following tables set forth our results of operations for the periods presented:

	Year Ended December 31,				Year Ended December 31,	
	2018	2017	$ Change	% Change	2018	2017
	($ in thousands)				(Percentage of total revenue)	
Revenue:						
Product	$ 102,123	$ 109,590	$ (7,467)	(7)%	98%	98%
Research services	2,238	2,041	197	10%	2%	2%
Total revenue	104,361	111,631	(7,270)	(7)%	100%	100%
Cost of revenue:						
Product	90,660	92,052	(1,392)	(2)%	87%	82%
Research services	1,032	908	124	14%	1%	1%
Gross profit	12,669	18,671	(6,002)	(32)%	12%	17%
Operating expenses:						
Research and development	6,319	6,180	139	2%	6%	6%
Sales and marketing	13,794	12,604	1,190	9%	13%	11%
General and administrative	19,116	19,023	93	0%	18%	17%
Impairment of construction in progress	7,356	—	7,356	100%	7%	—%
Total operating expenses	46,585	37,807	8,778	23%	45%	34%
Loss from operations	(33,916)	(19,136)	(14,780)	77%	(32)%	(17)%
Interest expense, net	(524)	(185)	(339)	183%	(1)%	(0)%
Total interest expense, net	(524)	(185)	(339)	183%	(1)%	(0)%
Net loss	$ (34,440)	$ (19,321)	$ (15,119)	78%	(33)%	(17)%

Revenue

	Year Ended December 31,				Change	
	2018		2017			
	Amount	Percentage of Revenue	Amount	Percentage of Revenue	Amount	Percentage
	($ in thousands)					
Revenue:						
Product	$ 102,123	98%	$ 109,590	98%	$ (7,467)	(7)%
Research services	2,238	2%	2,041	2%	197	10%
Total revenue	$ 104,361	100%	$ 111,631	100%	$ (7,270)	(7)%

The following chart sets forth product shipments in square feet for the periods presented:

	Year Ended December 31,		Change	
	2018	2017	Amount	Percentage
Product shipments in square feet (in thousands)	34,435	37,519	(3,084)	(8)%

Total revenue decreased by $7.2 million, or 7%, in 2018 to $104.4 million from $111.6 million in 2017 due principally to a decrease in product revenue.

Product revenue decreased by $7.5 million, or 7%, to $102.1 million in 2018 from $109.6 million in 2017. This decrease was principally the result of a decrease in project revenue in the subsea market and due to the conclusion of the multiyear petrochemical project with Reliance Industries Limited, offset, in part, by growth in our core petrochemical and refinery markets, particularly in Asia, and in the building materials market. Product revenue for the year ended 2018 included $21.4 million in sales to Distribution International, Inc. Product revenue for the year ended 2017 included $16.7 million in sales to Distribution International, Inc. and $13.2 million in sales to TechnipFMC plc.

The average selling price per square foot of our products increased by an effective $0.04, or 1%, to $2.96 per square foot for the year ended December 31, 2018 from $2.92 per square foot for the year ended December 31, 2017. The increase in average selling price reflected the impact of price increases enacted in early 2018. This increase in average selling price had the effect of increasing product revenue by approximately $1.4 million for the year ended December 31, 2018.

In volume terms, product shipments decreased 3.1 million square feet, or 8%, to 34.4 million square feet of aerogel products for the year ended December 31, 2018, as compared to 37.5 million square feet in the year ended December 31, 2017. The decrease in product volume had the effect of decreasing product revenue by approximately $8.9 million for the year ended December 31, 2018.

Research services revenue increased by $0.2 million, or 10%, to $2.2 million in 2018 from $2.0 million in 2017. The increase was primarily due to the timing and amount of funding available under research contracts during the year ended December 31, 2018 from the comparable period in 2017.

Product revenue as a percentage of total revenue was 98% of total revenue in both 2018 and 2017. Research services revenue was 2% of total revenue in both 2018 and 2017.

Cost of Revenue

	Year Ended December 31,						Change	
	2018			2017				
	Amount	Percentage of Related Revenue	Percentage of Total Revenue	Amount	Percentage of Related Revenue	Percentage of Total Revenue	Amount	Percentage
	($ in thousands)							
Cost of revenue:								
Product	$ 90,660	89%	87%	$ 92,052	84%	82%	$ (1,392)	(2)%
Research services	1,032	46%	1%	908	44%	1%	124	14%
Total cost of revenue	$ 91,692	88%	88%	$ 92,960	83%	83%	$ (1,268)	(1)%

Total cost of revenue decreased by $1.3 million, or 1%, to $91.7 million in 2018 from $93.0 million in 2017. The decrease in total cost of revenue was primarily the result of a decrease in product cost of revenue.

Product cost of revenue decreased $1.4 million, or 2%, to $90.7 million in 2018 from $92.1 million in 2017. The $1.4 million decrease was the result of a $0.8 million decrease in material costs and a $0.6 million decrease in manufacturing expense. The decrease in material costs was driven by a decrease of $0.9 million in warranty expense and the 3.1 million square feet, or 8%, decrease in product shipments period over period, offset, in part, by an increase in the cost of raw materials, particularly in the cost of silica materials, and an increase in the cost of freight of $0.5 million. The decrease in manufacturing expense was the result of decreases in maintenance expense of $1.0 million and utilities expense of $0.9 million, offset, in part, by increases in compensation and related costs of $0.8 million and other costs of $0.5 million.

Although product revenue decreased by 7% during 2018, manufacturing expense decreased by only 1% due principally to the high proportion of fixed manufacturing expense in our manufacturing operations. As a result, product cost of revenue as a percentage of product revenue increased to 89% during 2018 from 84% in 2017.

Research services cost of revenue increased by $0.1 million, or 14%, to $1.0 million in 2018 from $0.9 million in 2017. The increase in research services cost of revenue was due to the 10% increase in research services revenue during 2018 and an increase in the mix of outside services versus internal labor required to support the contracted research.

Gross Profit

	Year Ended December 31,				Change	
	2018		2017			
	Amount	Percentage of Revenue	Amount	Percentage of Revenue	Amount	Percentage
			($ in thousands)			
Gross profit	$ 12,669	12%	$ 18,671	17%	$ (6,002)	(32)%

Gross profit decreased $6.0 million, or 32%, to $12.7 million in 2018 from $18.7 million in 2017. This $6.0 million decrease was the result of the $7.2 million or 7% decrease in total revenue offset, in part, by the $1.3 million or 1% decrease in total cost of revenue. The decrease in revenue was principally the result of a decline in project revenue in the subsea market and due to the conclusion of the multiyear petrochemical project with Reliance Industries Limited. The $1.3 million decrease in total cost of revenue was the result of a $0.8 million decrease in material costs and a $0.6 million decrease in manufacturing expense, offset, in part by a $0.1 million increase in the cost of research services revenue.

Total cost of revenue decreased by only 1% despite the 7% decline in total revenue during 2018 due principally to the high proportion of fixed costs in our manufacturing facility. As a result, gross profit as a percentage of total revenue decreased to 12% of total revenue in 2018 as compared to 17% in 2017.

Research and Development Expenses

	Year Ended December 31,				Change	
	2018		2017			
	Amount	Percentage of Revenue	Amount	Percentage of Revenue	Amount	Percentage
			($ in thousands)			
Research and development expenses	$ 6,319	6%	$ 6,180	6%	$ 139	2%

Research and development expenses increased $0.1 million, or 2% to $6.3 million in 2018 from $6.2 million during 2017. The $0.1 million increase was the result of increases in compensation and related costs of $0.2 million offset, in part, by a decrease in professional fees of $0.1 million.

Sales and Marketing Expenses

	Year Ended December 31,				Change	
	2018		2017			
	Amount	Percentage of Revenue	Amount	Percentage of Revenue	Amount	Percentage
			($ in thousands)			
Sales and marketing expenses	$ 13,794	13%	$ 12,604	11%	$ 1,190	9%

Sales and marketing expenses increased by $1.2 million, or 9%, to $13.8 million in 2018 from $12.6 million during 2017. The $1.2 million increase was the result of increases in professional fees and commissions of $0.4 million, travel related costs of $0.6 million, and other external sales and marketing expense of $0.5 million offset, in part, by a decrease in compensation costs of $0.3 million.

General and Administrative Expenses

	Year Ended December 31,				Change	
	2018		2017			
	Amount	Percentage of Revenue	Amount	Percentage of Revenue	Amount	Percentage
			($ in thousands)			
General and administrative expenses	$ 19,116	18%	$ 19,023	17%	$ 93	0%

General and administrative expenses increased by $0.1 million, or less than 1%, to $19.1 million in 2018 from $19.0 million in 2017. The $0.1 million increase was the result of an increase in the provisions for uncollectible accounts receivable of $2.5 million, legal and professional fees of $0.6 million, and other general and administrative expenses of $0.3 million, offset, in part, by a decrease in patent enforcement costs of $2.7 million, and compensation and related costs of $0.6 million.

Impairment of Construction In Progress

We had previously completed the design and engineering for a second manufacturing facility to be located in Statesboro, Georgia supported by a package of incentives, including free land, from state and local governmental authorities. During 2016, we elected to delay construction of the facility due to our assessment of future demand. In December 2018, the local governmental authorities notified us that they will exercise their right to terminate the incentive package in February 2019 and to make the identified site available to other parties. In addition, we determined that due to our cumulative manufacturing process advancements since 2016 and expected additional improvements in the near future, we would not use the existing design and engineering to construct a second facility in any location. Accordingly, we determined that the design and engineering costs were not recoverable and recorded an impairment charge of $7.4 million on construction in progress assets during 2018. We did not record any impairments of construction in progress in 2017.

Interest Expense, net

	Year Ended December 31,				Change	
	2018		2017			
	Amount	Percentage of Revenue	Amount	Percentage of Revenue	Amount	Percentage
	($ in thousands)					
Interest expense, net	$ (524)	(1)%	$ (185)	(0)%	$ (339)	183%

Interest expense, net, consisting primarily of fees and interest expense associated with outstanding balances under our revolving credit agreement, was $0.5 million and $0.2 million in 2018 and 2017, respectively.

Liquidity and Capital Resources

Overview

We have experienced significant losses and invested substantial resources since our inception to develop, commercialize and protect our aerogel technology and to build a manufacturing infrastructure capable of supplying aerogel products at the volumes and costs required by our customers. These investments have included research and development and other operating expenses, capital expenditures and investment in working capital balances.

Through 2015, we experienced revenue growth and gained share in our target markets. Despite a decline in revenue in 2016, 2017 and 2018, our financial projections anticipated long-term revenue growth, increasing levels of gross profit and improved cash flow from operations. To support this growth, we initiated a plan in 2018 to increase the capacity of our East Providence, Rhode Island manufacturing facility to approximately 60 million square feet of aerogel blankets by the end of 2020. We may incur up to $1.0 million in capital expenditures to complete the plan during 2020. In line with our financial projections, we experienced strong growth in revenue, gross profit and cash flow from operations during 2019.

We have taken several actions during 2019 and to date in 2020 to increase the financial resources available to support current operating requirements. On January 30, 2019, we received a second $5.0 million prepayment pursuant to the supply agreement with BASF. On February 18, 2020, we completed an underwritten public offering of our common stock and received net proceeds of $14.8 million. On March 3, 2020, we extended the maturity of our revolving credit facility with SVB to April 28, 2021.

We believe that our existing cash balance, available credit and anticipated cash flows from operations will be sufficient to complete the planned capacity expansion of our East Providence manufacturing facility and to fund our planned strategic business initiatives.

However, in the future, we may need to supplement our cash balance, available credit and anticipated cash flows from operations with debt financings, customer prepayments, technology licensing agreements or equity financings to provide the capital necessary to complete future capacity expansions or to fund evolving strategic business initiatives.

Primary Sources of Liquidity

Our principal sources of liquidity are currently our cash and cash equivalents and our revolving credit facility with Silicon Valley Bank. Cash and cash equivalents consist primarily of cash and money market accounts on deposit with banks. As of December 31, 2019, we had $3.6 million of cash and cash equivalents.

On February 18, 2020, we completed an underwritten public offering of 1,955,000 shares of our common stock at an offering price of $8.25 per share. We received net proceeds of $14.8 million after deducting underwriting discounts of $1.0 million and offering expenses of approximately $0.4 million.

At December 31, 2019, we had debt obligations of $3.1 million related to borrowings under our revolving credit facility with Silicon Valley Bank, $0.9 million of outstanding letters of credit secured by our revolving credit facility and an obligation of $10.0 million associated with prepayments received pursuant to the BASF Supply Agreement.

We have maintained the revolving credit facility, as amended from time to time, with Silicon Valley Bank since March 2011. On March 3, 2020, our revolving credit facility was amended to extend the maturity date of the facility to April 28, 2021. The amendment to the credit facility also established certain minimum EBITDA levels with respect to the minimum Adjusted EBITDA financial covenant for the extended term.

Under our revolving credit facility, we are permitted to borrow a maximum of $20.0 million, subject to continued covenant compliance and borrowing base requirements. At our election, the interest rate applicable to borrowings under the revolving credit facility may be based on the prime rate or LIBOR. Prime rate-based rates vary from prime rate plus 0.75% per annum to prime rate plus 2.00% per annum, while LIBOR-based rates vary from LIBOR plus 3.75% per annum to LIBOR plus 4.25% per annum. In addition, we are required to pay a monthly unused revolving line facility fee of 0.5% per annum of the average unused portion of the revolving credit facility. We intend to extend or replace the facility prior to its maturity.

Under the revolving credit facility, we are required to comply with both non-financial and financial covenants, including the minimum EBITDA covenant, as defined in the loan agreement. At December 31, 2019, we were in compliance with all such covenants.

See “Risk Factors -- Risks Related to Our Business and Strategy -- We will require significant additional capital to pursue our growth strategy, but we may not be able to obtain additional financing on acceptable terms or at all” in this Annual Report on Form 10-K for the year ended December 31, 2019.

The amount available to us under the revolving credit facility at December 31, 2019 was $12.4 million after giving effect to the $3.1 million in outstanding borrowings and $0.9 million of outstanding letters of credit.

Analysis of Cash Flow

The following table summarizes our cash flows for the periods indicated:

	Year Ended December 31, 2019	2018	2017
	($ in thousands)		
Net cash provided by (used in):			
Operating activities	$ (1,054)	$ (8,654)	$ (4,606)
Investing activities	(2,112)	(3,593)	(6,118)
Financing activities	3,472	4,880	3,332
Net increase (decrease) in cash	306	(7,367)	(7,392)
Cash, beginning of period	3,327	10,694	18,086
Cash and cash equivalents, end of period	$ 3,633	$ 3,327	$ 10,694

Operating Activities

During 2019, we used $1.1 million in net cash in operating activities, as compared to the use of $8.7 million in net cash during 2018, a decrease in the use of cash of $7.6 million. This decrease in use of cash was the result of the decrease in net loss adjusted for non-cash items of $9.6 million, offset, in part, by a decrease in cash provided by changes in working capital of $2.0 million.

During 2018, we used $8.7 million net cash in operating activities, as compared to the use of $4.6 million in net cash during 2017, an increase in the use of cash of $4.1 million. This increase in use of cash was the result of the increase in net loss adjusted for non-cash items of $6.1 million, offset, in part, by an increase in cash provided by changes in working capital of $2.0 million.

Investing Activities

Net cash used in investing activities is primarily related to capital expenditures to support our growth. Net cash used in investing activities for 2019 and 2018 totaled $2.1 million and $3.6 million, respectively, in capital expenditures primarily for machinery and equipment to improve the throughput, efficiency and capacity of our East Providence facility.

Financing Activities

Net cash provided by financing activities in 2019 totaled $3.5 million and consisted of $125.8 million in borrowings under our revolving credit facility and $5.0 million in prepayment proceeds under the BASF supply agreement, offset, in part, by $126.8 million of repayments under our revolving credit facility and $0.5 million for payments for employee tax withholdings associated with the vesting of restricted stock units.

Net cash provided by financing activities in 2018 totaled $4.9 million and consisted of $56.7 million in borrowings under our revolving credit facility and $5.0 million in prepayment proceeds under the BASF supply agreement, offset, in part, by $56.3 million of repayments under our revolving credit facility and $0.5 million for payments for employee tax withholdings associated with the vesting of restricted stock units.

Capital Spending and Future Capital Requirements

We have made capital expenditures primarily to develop and expand our manufacturing capacity. Our capital expenditures totaled $2.1 million in 2019, $3.6 million in 2018 and $6.1 million in 2017. As of December 31, 2019, we had capital commitments of approximately $0.5 million, which included commitments for which we have entered into contracts as well as commitments authorized by our Board of Directors and relate to the enhancement of our existing production lines in our East Providence facility. These commitments consist primarily of costs for equipment and construction. We intend to fund capital expenditures related the expansion of capacity of our existing manufacturing facility with our existing cash balance, available credit and anticipated cash flows from operations.

Off-Balance Sheet Arrangements

Since inception, we have not engaged in any off balance sheet activities as defined in Item 303(a)(4) of Regulation S-K.

Contractual Obligations and Commitments

Operating Leases

We lease office space for our corporate offices in Northborough, Massachusetts, which expires in 2026, and warehouse space and land near our East Providence facility, which expire at various dates from 2018 through 2024, under non-cancelable operating lease agreements. See “Item 2 — Properties.” We also lease vehicles and equipment under non-cancelable operating leases that expire at various dates.

On June 29, 2016, we entered into a lease with Cabot II- MA1M03, LLC, or Cabot Properties, to lease approximately 51,650 square feet of space located at 30 Forbes Road, Northborough, MA 01532, the location of our current headquarters. The lease superseded a lease between us and Cabot Properties’ predecessor-in-interest. The term of the lease began on January 1, 2017 and ends on December 31, 2026. The annual base rent associated with the lease was approximately $408,000 during 2017 and has and will increase by approximately 3% annually during the lease term. The lease also provides for our payment of our pro rata share of real estate taxes and certain other expenses. Upon the expiration of the lease term, we will have the right to extend the lease for an additional three years.

Supply Agreement

In June 2016, we entered into a supply agreement and a side agreement with BASF SE. In February 2018, we entered into an amended and restated supply agreement and side agreement with BASF Polyurethanes GmbH (BASF). On January 14, 2019, we entered into the first addendum to the supply agreement with BASF (as amended and restated and after giving effect to the first addendum, the supply agreement). Pursuant to the supply agreement, we will sell exclusively to BASF certain products at annual volumes to be specified by BASF, subject to specified volume limits. Pricing is based on a cost-plus formula. The supply agreement also specifies the markets in which BASF is permitted to sell each of the products. BASF has no obligation to purchase any of the products under the supply agreement. The supply agreement will terminate on December 31, 2027 with respect to our Spaceloft A2 product, and on December 31, 2028 with respect to the newly developed product, if not renewed prior to such dates. Upon expiration of the supply agreement, we will be subject to a post-termination supply commitment for the specified products for an additional two years.

In addition to the customary terms associated with supply agreements, BASF, in its sole discretion, may make prepayments to us in the aggregate amount of up to $22.0 million during the term of the supply agreement. BASF made two prepayments to us in the aggregate amount of $5.0 million during 2018. BASF made an additional prepayment of $5.0 million to us in January 2019. We have secured our obligation to repay the prepayments with a first priority security interest in real estate, machinery and equipment located at our existing manufacturing facility in East Providence, Rhode Island. Additionally, we granted non-exclusive licenses to our Rhode Island subsidiary under our intellectual property as necessary to operate such machinery and equipment.

Beginning January 1, 2019, we will credit 25.3% of any amounts that we invoice for Spaceloft A2 sold to BASF against the outstanding balance of the 2018 prepayment. If any of the 2018 prepayment remains uncredited as of December 31, 2021, BASF may request that we repay the uncredited amount to BASF. After January 1, 2020, we will credit 50% of any amounts that we invoice for a newly developed product sold to BASF against the outstanding balance of the 2019 prepayment. After December 31, 2022, BASF may elect to have us credit 24.7% of any amounts we invoice for Spaceloft A2 sold to BASF against the outstanding balance of the 2019 prepayment or may request that we repay the uncredited amount to BASF. The specific terms of additional tranches of prepayments, if any, are to be agreed by us and BASF at a future date.

We may repay any prepayment balance to BASF at any time in whole or in part for any reason. In the event of a sale of all or substantially all of our assets or a change of control of Aspen, BASF may in certain instances have the right to terminate the supply agreement, in which case any remaining balance of prepayments as of such sale or change of control will be due and payable to BASF within 30 days of the relevant transaction.

Joint Development Agreement

In June 2016, we and BASF SE also entered into a Joint Development Agreement, or the JDA, setting forth the rights and obligations of us and BASF SE with respect to collaboration on the development and commercialization of new products. Under the JDA, each party may propose that the parties enter into joint efforts to seek to develop one or more products or services for commercialization on terms to be agreed by the parties. The JDA established a joint steering committee with equal representation from each of us and BASF SE to oversee any such collaboration. Unless otherwise agreed, all intellectual property created in the performance of joint development activities will generally be jointly owned by us and BASF SE. The JDA will have an initial term of two years or the duration of any project in process, with the option for the parties to renew at the expiration. Either party may terminate the JDA for any reason with 90-days prior notice to the other party, provided that such termination will not terminate any project under the JDA then in progress, with any such ongoing project able to be terminated by either party for any reason on 90-days prior notice to the other party.

Revolving Credit Facility

In March 2011, we entered into a revolving credit facility with Silicon Valley Bank. This facility has been amended at various dates through December 2019. On March 3, 2020, the Loan Agreement was further amended to extend the maturity date of the facility to April 28, 2021. Under the facility, we are permitted to borrow a maximum of $20.0 million, subject to continued covenant compliance and borrowing base requirements. At our election, the interest rate applicable to borrowings under the amended revolving credit facility may be based on the prime rate or LIBOR. Prime rate-based rates vary from prime rate plus 0.75% per annum to prime rate plus 2.00% per annum, while LIBOR-based rates vary from LIBOR plus 3.75% per annum to LIBOR plus 4.25% per annum. In addition, we are required to pay a monthly unused revolving line facility fee of 0.5% per annum of the average unused portion of the revolving credit facility. The credit facility has also been amended to establish certain minimum Adjusted EBITDA levels with respect to the minimum Adjusted EBITDA financial covenant for the extended term.

At December 31, 2019, the amount available to us under the revolving credit facility was $12.4 million after giving effect to $3.1 million in borrowings and $0.9 million of letters of credit outstanding under the facility.

Recent Accounting Pronouncements

Standards Implemented Since December 31, 2018

In February 2016, the Financial Accounting Standards Board (FASB) issued Accounting Standards Update (ASU) 2016-02, Leases (Topic 842). FASB ASU 2016-02 modified the accounting for leases and requires that all leases be recorded on the consolidated balance sheets as assets and liabilities. This standard was effective for fiscal years beginning after December 15, 2018. We adopted this standard on January 1, 2019 using the modified retrospective transition approach with the effective date as the date of initial application. As a result, we did not update financial information or provide the disclosures otherwise required under the new standard for dates and periods before January 1, 2019. To measure our lease liabilities, we used our incremental borrowing rate as of the date of adoption or the rate implicit in the lease, if available. The discount rate was applied to the remaining lease term and remaining payments at the date of adoption. We also elected the package of practical expedients under the new standard, which permitted us to not reassess prior conclusions about lease identification, lease classification, and initial direct costs. The most significant effects of this new standard on the consolidated financial statements related to the recognition of new right-of-use (ROU) assets and lease liabilities on the consolidated balance sheets and the provision of significant new disclosures about leasing activities. Upon adoption on January 1, 2019, we recognized operating lease liabilities of approximately $6.0 million with corresponding ROU assets of approximately $4.6 million. Additionally, we derecognized deferred rent liabilities of $1.4 million. This standard has not materially impacted our consolidated net loss or net cash used in operations. We also elected the short-term lease recognition exemption for all leases that qualify. For leases that qualify for this exemption, we do not recognize ROU assets or lease liabilities. In addition, we elected the practical expedient to not separate non-lease components from the associated lease components for all of our equipment leases.

Standards to be Implemented

We believe that the impact of recently issued accounting standards that are not yet effective will not have a material impact on our consolidated financial statements.

Critical Accounting Policies and Estimates

Our financial statements are prepared in accordance with accounting principles generally accepted in the United States of America. The preparation of our financial statements and related disclosures requires us to make estimates, assumptions and judgments that affect the reported amount of assets, liabilities, revenue, costs and expenses and related disclosures. We believe that the estimates, assumptions and judgments involved in these accounting policies have the greatest potential impact on our financial statements; and therefore, we consider these to be our critical accounting policies. Accordingly, we evaluate our estimates and assumptions on an ongoing basis. Our actual results may differ from these estimates under different assumptions and conditions. See note 2 to our consolidated financial statements included elsewhere in this Annual Report on Form 10-K for information about these critical accounting policies, as well as a description of our other significant accounting policies.

Revenue Recognition

We recognize product revenue from the sale of our line of aerogel products and research services revenue from the provision of services under contracts with various agencies of the U.S. government and other institutions. Product and research services revenue is recognized upon the satisfaction of contractual performance obligations. In general, our customary shipping terms are FOB shipping point. Products are typically delivered without significant post-sale obligations to customers other than standard warranty obligations for product defects. We provide warranties for our products and record the estimated cost within cost of sales in the period that the revenue is recorded. Our standard warranty period extends one to two years from the date of shipment, depending on the type of product purchased. Our warranties provide that our products will be free from defects in material and workmanship, and will, under normal use, conform to the specifications for the product. During the year ended December 31, 2018, test results indicated that tested samples performed outside the published performance specifications for a specific attribute of a product. We have completed our assessment of the impact of the testing results on our customer base and, based on that completed assessment, have determined that it is remote that we have incurred a liability as of December 31, 2019.

We did not record any warranty expense during the years ended December 31, 2019 and 2018. During the year ended December 31, 2017, we recorded warranty expense of $0.9 million. This warranty charge was related to a product claim for a specific application issue. This claim was outside of our typical experience. As of December 31, 2019, we had satisfied all outstanding warranty claims.

Research services revenue is derived from the execution of contracts awarded by the U.S. government, other government agencies and other institutions. Our research service arrangements require us to perform research to investigate new forms and applications of aerogel technology. We record revenue earned on research services contracts using the percentage-of-completion method in two ways: (1) for firm-fixed-price contracts, we accrue that portion of the total contract price that is allocable, on the basis of our estimates of costs incurred to date to total contract cost; (2) for cost-plus-fixed-fee contracts, we record revenue that is equal to total payroll cost incurred times a stated factor plus reimbursable expenses, to a stated upper limit. The primary cost in these arrangements is the labor effort expended in completing the research. Typically, the only deliverable, other than labor hours expended, is reporting research results to the customer or delivery of research grade aerogel products. Because the input measure of labor hours expended is also reflective of the output measure, it is a reliable means to measure the extent of progress towards completion. Contract costs and rates used to allocate overhead to contracts are subject to audit by the respective contracting government agency. Revisions in cost estimates and fees during the course of the contract are reflected in the accounting period in which the facts that require the revisions become known.

Stock-based Compensation

We maintain an equity incentive plan pursuant to which our board of directors may grant qualified and nonqualified stock options, restricted stock, restricted stock units and other stock-based awards to board members, officers, key employees and others who provide or have provided service to us.

We measure the costs associated with stock-based awards based on their estimated fair value at date of grant. We recognize the costs of stock-based awards as service, performance or market conditions are met. Future expense amounts for any particular quarterly or annual period could be affected by changes in our assumptions or changes in market conditions.

Stock Options

We use the Black-Scholes option-pricing model to estimate the fair value of stock option awards. The determination of the estimated fair value of stock option awards is based on a number of complex and subjective assumptions. These assumptions include the determination of the estimated fair value of the underlying security (prior to our initial public offering), the expected volatility of the underlying security, a risk-free interest rate, the expected term of the option, and the forfeiture rate for the award class. The following assumptions were used to estimate the fair value of the option awards:

	Year Ended December 31,		
	2019	**2018**	**2017**
Weighted-average assumptions:			
Expected term (in years)	5.81	5.93	5.86
Expected volatility	49.90%	47.68%	51.95%
Risk free rate	2.44%	2.76%	1.99%
Expected dividend yield	—%	—%	—%

- The expected term represents the period that our stock-based awards are expected to be outstanding and is determined using the simplified method described in ASC Topic 718, *Compensation — Stock Compensation*, for all grants. We believe this is a better representation of the estimated life than our actual limited historical exercise behavior.
- For the years ended December 31, 2019, 2018 and 2017, the expected volatility is based on the weighted-average volatility of up to 17 companies within various industries that we believe are similar to our own.
- The risk-free interest rate is based on U.S. Treasury zero-coupon issues with a remaining term equal to the expected life assumed at the date of grant.
- We use an expected dividend yield of zero, since we do not intend to pay cash dividends on our common stock in the foreseeable future, nor have we paid dividends on our common stock in the past.

During the year ended December 31, 2017, we adopted the provisions of ASU 2016-09 related to the timing of accounting for the forfeitures of share based awards using a modified retrospective method. Under these provisions, we record the impact of forfeitures of service based awards at the time an award is forfeited. Our adoption of the provisions resulted in a cumulative-effect adjustment to equity as of January 1, 2017 of $0.3 million. Prior to our adoption of ASU 2016-09, forfeitures were required to be estimated at the time of grant and revised, if necessary, in subsequent periods, if actual forfeitures differed from those estimates. Forfeitures were estimated based on voluntary termination behavior as well as analysis of actual option forfeitures.

For stock options that contained a market condition issued to our chief executive officer during the year ended December 31, 2015, we used a Monte Carlo Simulation model to estimate the grant date fair value of awards expected to vest. The simulation model was based on the Black Scholes option-pricing model and a number of complex assumptions including (i) if the vesting condition is satisfied within the time-vesting periods, and (ii) the date the common stock price target is met per the terms of the agreement. On November 7, 2018, we entered into an executive agreement with the CEO which modified the change in control provisions for the outstanding stock options that contained a market condition. This modification resulted in the recognition of additional compensation expense of less than $0.1 million during the year ended December 31, 2018.

For the restricted stock award issued to our Chief Executive Officer during the year ended December 31, 2015 that contain a performance condition, we assess the probability that the performance condition will be satisfied. On August 2, 2017, we modified the performance target with respect to 78,125 shares of these awards. As of December 31, 2019, we have recorded $0.1 million in compensation expense to date in connection with the award.

Item 7A. QUANTITATIVE AND QUALITATIVE DISCLOSURES ABOUT MARKET RISK

Market risk represents the risk of loss that may impact our financial position due to adverse changes in financial market prices and rates. Our market risk exposure results primarily from fluctuations in interest rates as well as from inflation. In the normal course of business, we are exposed to market risks, including changes in interest rates which affect our line of credit under our revolving credit facility as well as cash flows. We may also face additional exchange rate risk in the future as we expand our business internationally.

Interest Rate Risk

We are exposed to changes in interest rates in the normal course of our business. At December 31, 2019, we had unrestricted cash and cash equivalents of $3.6 million. These amounts were held for working capital and capital expansion purposes and were invested primarily in deposit accounts at a major financial institution in North America. Due to the short-term nature of these investments, we believe that our exposure to changes in the fair value of our cash as a result of changes in interest rates is not material.

As of December 31, 2019, we had $3.1 million drawn and outstanding on our revolving credit facility. At December 31, 2019, we also had $0.9 million of outstanding letters of credit supported by the revolving credit facility.

Under our revolving credit facility, we are permitted to borrow a maximum of $20.0 million, subject to continued covenant compliance and borrowing base requirements. At our election, the interest rate applicable to borrowings under the revolving credit facility may be based on the prime rate or LIBOR. Prime rate-based rates vary from prime rate plus 0.75% per annum to prime rate plus 2.00% per annum, while LIBOR-based rates vary from LIBOR plus 3.75% per annum to LIBOR plus 4.25% per annum. In addition, we are required to pay a monthly unused revolving line facility fee of 0.5% per annum of the average unused portion of the revolving credit facility. The maturity date of our revolving credit facility is April 28, 2021.

At December 31, 2019, the amount available to us under the revolving credit facility was $12.4 million after giving effect to the $3.1 million in borrowings and $0.9 million of letters of credit outstanding under the facility.

Inflation Risk

Although we expect that our operating results will be influenced by general economic conditions, we do not believe that inflation has had a material effect on our results of operations during the periods presented in this report. However, our business may be affected by inflation in the future.

Foreign Currency Exchange Risk

We are subject to inherent risks attributed to operating in a global economy. Virtually all of our revenue, receivables, purchases and debts are denominated in U.S. dollars.

Report of Independent Registered Public Accounting Firm

To the Stockholders and Board of Directors
Aspen Aerogels, Inc.:

Opinions on the Consolidated Financial Statements and Internal Control Over Financial Reporting

We have audited the accompanying consolidated balance sheets of Aspen Aerogels, Inc. and subsidiaries (the Company) as of December 31, 2019 and 2018, the related consolidated statements of operations, stockholders' equity, and cash flows for each of the years in the three-year period ended December 31, 2019, and the related notes and financial statement schedule II – Valuation and Qualifying Accounts (collectively, the consolidated financial statements). We also have audited the Company's internal control over financial reporting as of December 31, 2019, based on criteria established in *Internal Control – Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission.

In our opinion, the consolidated financial statements referred to above present fairly, in all material respects, the financial position of the Company as of December 31, 2019 and 2018, and the results of its operations and its cash flows for each of the years in the three-year period ended December 31, 2019, in conformity with U.S. generally accepted accounting principles. Also in our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2019 based on criteria established in *Internal Control – Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission.

Change in Accounting Principle

As discussed in Note 2 to the consolidated financial statements, the Company has changed its method of accounting for leases as of January 1, 2019, in accordance with the adoption of Accounting Standards Codification (ASC) Topic 842, *Leases*.

Basis for Opinions

The Company's management is responsible for these consolidated financial statements, for maintaining effective internal control over financial reporting, and for its assessment of the effectiveness of internal control over financial reporting, included in the accompanying Management's Report on Internal Control over Financial Reporting. Our responsibility is to express an opinion on the Company's consolidated financial statements and an opinion on the Company's internal control over financial reporting based on our audits. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) (PCAOB) and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audits to obtain reasonable assurance about whether the consolidated financial statements are free of material misstatement, whether due to error or fraud, and whether effective internal control over financial reporting was maintained in all material respects.

Our audits of the consolidated financial statements included performing procedures to assess the risks of material misstatement of the consolidated financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the consolidated financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements. Our audit of internal control over financial reporting included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, and testing and evaluating the design and operating effectiveness of internal control based on the assessed risk. Our audits also included performing such other procedures as we considered necessary in the circumstances. We believe that our audits provide a reasonable basis for our opinions.

Definition and Limitations of Internal Control Over Financial Reporting

A company's internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company’s internal control over financial reporting includes those policies and procedures that (1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (3) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company’s assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Also, projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

/s/ KPMG LLP

We have served as the Company’s auditor since 2002.

Hartford, Connecticut
March 6, 2020

ASPEN AEROGELS, INC.

Consolidated Balance Sheets

	December 31, 2019	December 31, 2018
	(In thousands, except share and per share data)	
Assets		
Current assets:		
Cash and cash equivalents	$ 3,633	$ 3,327
Accounts receivable, net of allowances of $144 and $2,877	32,254	25,565
Inventories	8,768	7,318
Prepaid expenses and other current assets	1,114	1,041
Total current assets	45,769	37,251
Property, plant and equipment, net	53,617	61,699
Operating lease right-of-use assets	4,032	—
Other long-term assets	84	73
Total assets	$ 103,502	$ 99,023
Liabilities and Stockholders' Equity		
Current liabilities:		
Accounts payable	$ 12,596	$ 12,392
Accrued expenses	8,057	3,864
Revolving line of credit	3,123	4,181
Deferred revenue	5,620	2,629
Operating lease liabilities	1,038	—
Total current liabilities	30,434	23,066
Deferred rent	—	1,218
Prepayment liability	9,786	4,485
Operating lease liabilities long-term	4,292	—
Total liabilities	44,512	28,769
Commitments and contingencies (Note 10)		
Stockholders' equity:		
Preferred stock, $0.00001 par value; 5,000,000 shares authorized, no shares issued or outstanding at December 31, 2019 and 2018	—	—
Common stock, $0.00001 par value; 125,000,000 shares authorized, 24,302,504 and 23,973,517 shares issued and outstanding at December 31, 2019 and December 31, 2018, respectively	—	—
Additional paid-in capital	545,140	541,839
Accumulated deficit	(486,150)	(471,585)
Total stockholders' equity	58,990	70,254
Total liabilities and stockholders' equity	$ 103,502	$ 99,023

See accompanying notes to consolidated financial statements.

ASPEN AEROGELS, INC.

Consolidated Statements of Operations

	Year Ended December 31, 2019	2018	2017
		(In thousands, except share and per share data)	
Revenue:			
Product	$ 136,934	$ 102,123	$ 109,590
Research services	2,441	2,238	2,041
Total revenue	139,375	104,361	111,631
Cost of revenue:			
Product	111,759	90,660	92,052
Research services	1,332	1,032	908
Gross profit	26,284	12,669	18,671
Operating expenses:			
Research and development	8,407	6,319	6,180
Sales and marketing	15,557	13,794	12,604
General and administrative	16,479	19,116	19,023
Impairment of construction in progress	—	7,356	—
Total operating expenses	40,443	46,585	37,807
Loss from operations	(14,159)	(33,916)	(19,136)
Interest expense, net	(406)	(524)	(185)
Total interest expense, net	(406)	(524)	(185)
Net loss	$ (14,565)	$ (34,440)	$ (19,321)
Net loss per share:			
Basic and diluted	$ (0.60)	$ (1.45)	$ (0.83)
Weighted-average common shares outstanding:			
Basic and diluted	24,099,438	23,738,852	23,390,235

See accompanying notes to consolidated financial statements.

ASPEN AEROGELS, INC.

Consolidated Statements of Stockholders' Equity
(In thousands, except share and per share data)

	Preferred Stock $0.00001 Par Value		Common Stock $0.00001 Par Value		Additional Paid-in Capital	Accumulated Deficit	Total Stockholders' Equity
	Shares	Value	Shares	Value			
Balance at December 31, 2016	—	$ —	23,369,838	$ —	$ 533,088	$ (417,524)	$ 115,564
Net loss	—	—	—	—	—	(19,321)	(19,321)
Adoption of new accounting standard	—	—	—	—	300	(300)	—
Stock compensation expense	—	—	—	—	5,091	—	5,091
Issuance of restricted stock	—	—	86,023	—	—	—	—
Retirement of restricted stock	—	—	(12,289)	—	—	—	—
Vesting of restricted stock units	—	—	199,617	—	(391)	—	(391)
Balance at December 31, 2017	—	$ —	23,643,189	$ —	$ 538,088	$ (437,145)	$ 100,943
Net loss	—	—	—	—	—	(34,440)	(34,440)
Stock compensation expense	—	—	—	—	4,302	—	4,302
Issuance of restricted stock	—	—	58,062	—	—	—	—
Vesting of restricted stock units	—	—	272,266	—	(551)	—	(551)
Balance at December 31, 2018	—	$ —	23,973,517	$ —	$ 541,839	$ (471,585)	$ 70,254
Net loss	—	—	—	—	—	(14,565)	(14,565)
Stock compensation expense	—	—	—	—	3,771	—	3,771
Issuance of restricted stock	—	—	50,328	—	—	—	—
Vesting of restricted stock units	—	—	278,659	—	(470)	—	(470)
Balance at December 31, 2019	—	$ —	24,302,504	$ —	$ 545,140	$ (486,150)	$ 58,990

See accompanying notes to consolidated financial statements.

ASPEN AEROGELS, INC.

Consolidated Statements of Cash Flows

	Year Ended December 31, 2019	2018	2017
	(In thousands)		
Cash flows from operating activities:			
Net loss	$ (14,565)	$ (34,440)	$ (19,321)
Adjustments to reconcile net loss to net cash used in operating activities:			
Depreciation and amortization	10,213	10,787	10,753
Impairment of construction in progress	—	7,356	—
Provision for bad debt	—	2,922	455
Stock compensation expense	3,771	4,302	5,091
Reduction in the carrying amount of operating lease right-of-use assets	947	—	—
Lease incentives	—	(121)	(111)
Other	—	—	(1)
Changes in operating assets and liabilities:			
Accounts receivable	(6,689)	(1,723)	(9,159)
Inventories	(1,450)	1,597	3,953
Prepaid expenses and other assets	(84)	261	411
Accounts payable	141	1,557	1,269
Accrued expenses	4,344	(2,056)	1,821
Deferred revenue	3,392	810	261
Operating lease liabilities	(1,018)	—	—
Other liabilities	(56)	94	(28)
Net cash used in operating activities	(1,054)	(8,654)	(4,606)
Cash flows from investing activities:			
Capital expenditures	(2,112)	(3,593)	(6,118)
Net cash used in investing activities	(2,112)	(3,593)	(6,118)
Cash flows from financing activities:			
Proceeds from (repayments of) borrowings under line of credit, net	(1,058)	431	3,750
Prepayment proceeds under customer supply agreement	5,000	5,000	—
Repayment of obligations under capital lease	—	—	(27)
Payments made for employee restricted stock tax withholdings	(470)	(551)	(391)
Net cash provided by financing activities	3,472	4,880	3,332
Net increase (decrease) in cash	306	(7,367)	(7,392)
Cash and cash equivalents at beginning of period	3,327	10,694	18,086
Cash and cash equivalents at end of period	$ 3,633	$ 3,327	$ 10,694
Supplemental disclosures of cash flow information:			
Interest paid	$ 440	$ 338	$ 220
Income taxes paid	$ —	$ —	$ —
Supplemental disclosures of non-cash activities:			
Initial recognition of operating lease liabilities related to right-of-use assets	$ 5,995	$ —	$ —
Right-of-use assets obtained in exchange for new operating lease liabilities	$ 353	$ —	$ —
Changes in accrued capital expenditures	$ 63	$ 182	$ (3,681)
Capitalized interest	$ —	$ 44	$ —

See accompanying notes to consolidated financial statements.

ASPEN AEROGELS, INC.

NOTES TO CONSOLIDATED FINANCIAL STATEMENTS

(1) Description of Business

Nature of Business

Aspen Aerogels, Inc. (the Company) is an aerogel technology company that designs, develops and manufactures innovative, high-performance aerogel insulation used primarily in the energy infrastructure and building materials markets. The Company also conducts research and development related to aerogel technology supported by funding from several agencies of the U.S. government and other institutions in the form of research and development contracts.

The Company maintains its corporate offices in Northborough, Massachusetts. The Company has three wholly owned subsidiaries: Aspen Aerogels Rhode Island, LLC, Aspen Aerogels Germany, GmbH and Aspen Aerogels Georgia, LLC.

On June 18, 2014, the Company completed the initial public offering (IPO) of its common stock.

Liquidity

During the year ended December 31, 2019, the Company incurred a net loss of $14.6 million and used $1.1 million of cash in operations. The Company had a cash and cash equivalents balance of $3.6 million and outstanding borrowings under its revolving line of credit of $3.1 million as of December 31, 2019 (see note 7). After giving effect to the outstanding borrowings and letters of credit, the additional amount available to the Company at December 31, 2019 under the revolving line of credit was $12.4 million. The existing revolving line of credit matures on April 28, 2021. On February 18, 2020, the Company received net proceeds of $14.8 million upon the completion of an underwritten public offering of the Company's common stock.

The Company is making investments to increase capacity at its existing manufacturing facility in East Providence, Rhode Island and to develop new technologies and strategic business opportunities. The Company expects its existing cash balance, the amount anticipated to be available under the existing revolving line of credit and anticipated cash flows from operations will be sufficient to complete the planned capacity expansion and to fund its planned strategic business opportunities.

However, in the future, the Company may need to supplement its cash balance, available credit and anticipated cash flows from operations with debt financings, customer prepayments, technology licensing agreements or equity financings to provide the capital necessary to complete future capacity expansions or to fund evolving strategic business initiatives.

(2) Summary of Basis of Presentation and Significant Accounting Policies

Principles of Consolidation

The accompanying consolidated financial statements, which have been prepared in accordance with U.S. generally accepted accounting principles (U.S. GAAP), include the accounts of the Company and its wholly owned subsidiaries. All intercompany balances and transactions have been eliminated in consolidation.

Use of Estimates

The preparation of the consolidated financial statements requires the Company to make a number of estimates and assumptions that affect the reported amounts of assets and liabilities at the date of the consolidated financial statements and the reported amounts of revenues and expenses during the reporting period. Significant items subject to such estimates and assumptions include allowances for doubtful accounts, sales returns and allowances, product warranty costs, inventory valuation, the carrying amount of property and equipment, stock-based compensation and deferred income taxes. The Company evaluates its estimates and assumptions on an on-going basis using historical experience and other factors, including the current economic environment, which are believed to be reasonable under the circumstances. Management adjusts such estimates and assumptions when facts and circumstances warrant. Illiquid credit markets, volatile equity markets and declines in business investment can increase the uncertainty inherent in such estimates and assumptions. As future events and their effects cannot be determined with precision, actual results could differ significantly from these estimates. Changes in these estimates resulting from continuing changes in the economic environment will be reflected in the financial statements in future periods.

Cash and Cash Equivalents

Cash equivalents include short-term, highly liquid instruments, which consist of money market accounts. All cash and cash equivalents are maintained with major financial institutions in North America. Deposits with these financial institutions may exceed the amount of insurance provided on such deposits; however, these deposits typically may be redeemed upon demand and, therefore, bear minimal risk.

Concentration of Credit Risk

Financial instruments, which potentially expose the Company to concentrations of credit risk, consist principally of accounts receivable. The Company's customers are primarily insulation distributors, insulation contractors, insulation fabricators and select end-users located throughout the world. The Company performs ongoing credit evaluations of its customers' financial condition and generally requires no collateral to secure accounts receivable. The Company maintains an allowance for doubtful accounts based on its assessment of the collectability of accounts receivable. The Company reviews the allowance for doubtful accounts quarterly. During the year ended December 31, 2019, the Company did not record any charges for uncollectible accounts receivable. During the year ended December 31, 2018, the Company recorded a charge for uncollectible accounts receivable of $2.9 million related to four customers of which one customer accounted for $2.8 million of that charge. During the year ended December 31, 2019, the Company received collections of $0.3 million from the customer. The Company subsequently determined that collection of the remaining unpaid accounts receivable from this customer of $2.6 million is unlikely due to the customer's filing of judicial reorganization under Brazilian laws. Therefore, the Company recorded a write-off of the accounts receivable and the corresponding allowance for doubtful accounts. Allowance for doubtful accounts was zero and $2.8 million at December 31, 2019 and 2018, respectively. The Company does not have any off-balance-sheet credit exposure related to its customers.

For the year ended December 31, 2019, two customers represented 20% and 13% of total revenue, respectively. For the year ended December 31, 2018, one customer represented 20% of total revenue. For the year ended December 31, 2017, two customers represented 15% and 12% of total revenue, respectively.

At December 31, 2019, the Company had two customers that accounted for 19% and 16% of accounts receivable, respectively. At December 31, 2018, the Company had one customer that accounted for 18% accounts receivable.

Inventories

Inventory consists of finished products and raw materials. Inventories are carried at lower of cost, determined using the first-in, first-out (FIFO) method, and net realizable value. Cost includes materials, labor and manufacturing overhead. Manufacturing overhead is allocated to the costs of conversion based on normal capacity of the Company's production facility. Abnormal freight, handling costs and material waste is expensed in the period it occurs.

The Company periodically reviews its inventories and makes provisions as necessary for estimated excess, obsolete or damaged goods to ensure values approximate the lower of cost and net realizable value. The amount of any such provision is equal to the difference between the cost of inventory and the estimated net realizable value based upon assumptions about future demand, selling prices and market conditions.

Property, Plant and Equipment, Net

Property, plant and equipment are stated at cost. Expenditures for maintenance and repairs are charged to expense as incurred, whereas major betterments are capitalized as additions to property, plant and equipment.

Depreciation on plant and equipment is calculated on the straight-line method over the estimated useful lives of the assets. Assets related to leasehold improvements are amortized on a straight-line basis over the shorter of the lease term or estimated useful life of the asset.

Assets utilized in the Company's operations that are taken out of service with no future use are charged to cost of revenue or operating expenses, depending on the department in which the asset was utilized. Impairments of construction in progress are charged to operating expenses upon the determination of no future use.

Other Assets

Other assets primarily include long-term deposits.

Impairment of Long-Lived Assets

Long-lived assets are reviewed for impairment whenever events or changes in circumstances indicate that the carrying amount of an asset or asset group may not be recoverable. Recognition and measurement of a potential impairment is performed on assets grouped with other assets and liabilities at the lowest level where identifiable cash flows are largely independent of the cash flows of other assets and liabilities. Recoverability of assets to be held and used is measured by a comparison of the carrying amount of an asset or asset group to future undiscounted net cash flows expected to be generated by the asset or asset group. If the carrying amount of an asset or asset group exceeds its estimated undiscounted future cash flows, an impairment charge is recognized for the amount by which the carrying amount of the asset or asset group exceeds the fair value of the asset or asset group. Fair value is determined through various valuation techniques including discounted cash flow models, quoted market values and third-party independent appraisals, as considered necessary.

During 2016, the Company completed the design and engineering for a second manufacturing facility to be located in Statesboro, Georgia. At that time, the Company elected to delay construction of the facility due to its assessment of future demand. In December 2018, the Company determined that due to its cumulative manufacturing process advancements since 2016 and expected additional improvements in the near future, it will not use the existing design and engineering to construct a second facility in any location. Accordingly, the Company determined that the design and engineering costs were not recoverable and recorded an impairment charge of $7.4 million on construction in progress assets during 2018.

Leases

On January 1, 2019, the Company adopted Accounting Standards Update (ASU) 2016-02, Leases (Topic 842). See note 9 for further details. Prior to the Company's adoption of ASU 2016-02, the Company recorded the difference between rent expense recognized on a straight-line basis and the contractual payments as deferred rent. The short-term portion of deferred rent is included within accrued expenses on the consolidated balance sheet as of December 31, 2018.

Revenue Recognition

On January 1, 2018, the Company adopted Accounting Standards Codification 606, Revenue from Contracts with Customers (ASC 606). See note 3 for further details.

Warranty

The Company provides warranties for its products and records the estimated cost within cost of sales in the period that the related revenue is recorded. The Company's standard warranty period extends to one year from the date of shipment. This standard warranty provides that the Company's products will be free from defects in material and workmanship, and will, under normal use, conform to the specifications for the product.

The Company's products may be utilized in systems that involve new technical demands and new configurations. Accordingly, the Company regularly reviews and assesses whether warranty reserves should be recorded in the period the related revenue is recorded. For an initial shipment of product for use in a system with new technical demands or new configurations and where the Company is unsure of meeting the customer's specifications, the Company will defer the recognition of product revenue and related costs until written customer acceptance is obtained.

The Company performs periodic testing of its aerogel blankets to ensure compliance with published performance specifications. From time to time, tests may indicate a product could potentially perform outside of these specifications. At that time, additional testing is initiated or the Company may conduct a root cause investigation. During the year ended December 31, 2018, test results indicated that tested samples performed outside the published performance specifications for a specific attribute of a product. The Company has completed its assessment of the impact of the testing results on its customer base and, based on that completed assessment, has determined that it is remote that the Company has incurred a liability as of December 31, 2019.

The Company did not record any warranty expense during the years ended December 31, 2019 and 2018. During the year ended December 31, 2017, the Company recorded warranty expense of $0.9 million. This warranty charge was related to a product claim for a specific product application issue. This claim was outside of the Company's typical experience. As of December 31, 2019, the Company had satisfied all outstanding warranty claims.

Shipping and Handling Costs

Shipping and handling costs are classified as a component of cost of revenue. Customer payments of shipping and handling costs are recorded as product revenue.

Stock-based Compensation

The Company grants share-based awards to its employees and non-employee directors. All share-based awards granted, including grants of stock options, restricted stock and restricted stock units (RSUs), are recognized in the statement of operations based on their fair value as of the date of grant. Expense is recognized on a straight-line basis over the requisite service period for all awards with service conditions. For performance-based awards, the grant date fair value is recognized as expense when the condition is probable of being achieved, and then on a graded basis over the requisite service period. The Company uses the Black-Scholes option-pricing model to determine the fair value of service-based option awards. The Black-Scholes model requires the use of a number of complex and subjective assumptions including fair value of the underlying security, the expected volatility of the underlying security, a risk-free interest rate and the expected term of the option.

The fair value of restricted stock and RSUs is determined using the closing price of the Company's common stock on the date of grant. All shares of restricted stock are not transferable until vested. Restricted stock is typically issued to non-employee directors and typically vests over a one-year period from the date of issuance. RSUs are issued to employees and typically vest over a three-year period from the date of issuance. The fair value of restricted stock and RSUs upon which vesting is solely service-based is expensed ratably over the vesting period. If the service condition for shares of restricted stock is not met for any reason, the shares of unvested restricted stock will be forfeited and returned to the Company.

For stock options that contain a market condition, the Company uses the Monte-Carlo simulation option-pricing model to determine the fair value of the awards. In addition to the input assumptions used in the Black-Scholes model, the Monte-Carlo simulation option-pricing model factors the probability that the specific market condition may or may not be satisfied into the valuation. Stock-based compensation expense for awards with a market condition is recognized on a straight-line basis over the requisite service period for each such award.

Pursuant to the "evergreen" provisions of the 2014 Employee, Director and Consultant Equity Incentive Plan, the number of shares of common stock authorized for issuance under the plan automatically increased by 479,470 shares to 7,488,930 shares effective January 1, 2019.

Research and Development

Costs incurred in the Company's research and development activities include compensation and related costs, services provided by third-party contractors, materials and supplies and are classified as research and development expenses as incurred. Research and development costs directly associated with research services revenue are classified as research services in cost of revenue.

Earnings per Share

The Company calculates net loss per common share based on the weighted-average number of common shares outstanding during each period. Potential common stock equivalents are determined using the treasury stock method. The weighted-average number of common shares included in the computation of diluted net income (loss) gives effect to all potentially dilutive common equivalent shares, including outstanding stock options and RSUs. Common equivalent shares are excluded from the computation of diluted net loss per share if their effect is antidilutive.

Income Taxes

Income taxes are accounted for under the asset and liability method. Deferred tax assets and liabilities are recognized for the future tax consequences attributable to differences between the financial statement carrying amounts of existing assets and liabilities and their respective tax bases and operating loss and tax credit carryforwards. Deferred tax assets and liabilities are measured using enacted tax rates expected to apply to taxable income in the years in which those temporary differences are expected to be recovered or settled. The effect on deferred tax assets and liabilities of a change in tax rates is recognized in income in the period that includes the enactment date.

The Company recognizes the effect of income tax positions only if those positions are more likely than not of being sustained. The Company accounts for uncertain tax positions using a recognition threshold and measurement attribute for the financial statement recognition and measurement of a tax position taken or expected to be taken in a tax return. Differences between tax positions taken in a tax return and amounts recognized in the financial statements are recorded as adjustments to income taxes payable or receivable, or adjustments to deferred taxes, or both. Changes in recognition or measurement are reflected in the period in which the change in judgment occurs. The Company recognizes penalties and interest related to uncertain tax positions, if any, as a component of income tax expense.

Segments

Operating segments are identified as components of an enterprise about which separate, discrete financial information is available for evaluation by the chief operating decision maker in making decisions on how to allocate resources and assess performance. The Company's chief operating decision maker is the Chief Executive Officer. The Company's chief operating decision maker reviews consolidated operating results to make decisions about allocating resources and assessing performance for the entire Company. The Company views its operations and manages its business as one operating segment.

Information about the Company's total revenues, based on shipment destination or services location, is presented in the following table:

	Year Ended December 31, 2019	2018	2017
	(In thousands)		
Revenue:			
U.S.	$ 58,328	$ 41,733	$ 51,439
International	81,047	62,628	60,192
Total revenue	$ 139,375	$ 104,361	$ 111,631

Recently Issued Accounting Standards

From time to time, new accounting pronouncements are issued by the Financial Accounting Standards Board or other standard setting bodies. Recently issued standards typically do not require adoption until a future effective date. Prior to their effective date, the Company evaluates the pronouncements to determine the potential effects of adoption to its consolidated financial statements.

Standards Implemented Since December 31, 2018

In February 2016, the FASB issued ASU 2016-02, Leases (Topic 842). FASB ASU 2016-02 modified the accounting for leases and requires that all leases be recorded on the consolidated balance sheets as assets and liabilities. This standard was effective for fiscal years beginning after December 15, 2018. The Company adopted this standard on January 1, 2019 using the modified retrospective transition approach with the effective date as the date of initial application. As a result, the Company did not update financial information or provide the disclosures otherwise required under the new standard for dates and periods before January 1, 2019. To measure its lease liabilities, the Company used its incremental borrowing rate as of the date of adoption or the rate implicit in the lease, if available. The discount rate was applied to the remaining lease term and remaining payments at the date of adoption. The Company also elected the package of practical expedients under the new standard, which permitted the Company to not reassess prior conclusions about lease identification, lease classification, and initial direct costs. The most significant effects of this new standard on the consolidated financial statements related to the recognition of new ROU assets and lease liabilities on the consolidated balance sheets and the provision of significant new disclosures about leasing activities. Upon adoption on January 1, 2019, the Company recognized operating lease liabilities of approximately $6.0 million with corresponding ROU assets of approximately $4.6 million. Additionally, the Company derecognized deferred rent liabilities of $1.4 million. This standard has not materially impacted the Company's consolidated net loss or net cash used in operations. The Company also elected the short-term lease recognition exemption for all leases that qualify. For leases that qualify for this exemption, the Company does not recognize ROU assets or lease liabilities. In addition, the Company elected the practical expedient to not separate non-lease components from the associated lease components for all of its equipment leases.

Standards to be Implemented After December 31, 2019

The Company believes that the impact of recently issued accounting standards that are not yet effective will not have a material impact on its consolidated financial statements.

(3) Revenue from Contracts with Customers

On January 1, 2018, the Company Adopted Accounting Standards Codification 606, Revenue from Contracts with Customers (ASC 606) using the modified retrospective method for all contracts not completed as of the date of adoption. The adoption of ASC 606 did not have a material impact on the allocation and timing of the recognition of previously reported revenues from the sale of products, subsea projects or the performance of research services. In addition, the Company determined that there are no incremental contract costs or contract fulfillment costs associated with the adoption of ASC 606. The reported results for 2019 and 2018 reflect the application of ASC 606 guidance while the reported results for 2017 were prepared under the guidance of ASC 605. The adoption of ASC 606 represented a change in accounting principle that more closely aligns revenue recognition with the delivery of the Company's product or performance of research services and will provide financial statement readers with enhanced disclosures.

Revenue Recognition

Revenue is recognized when a customer obtains control of promised goods or services in an amount that reflects the consideration which the entity expects to receive in exchange for those goods or services. To determine revenue recognition for arrangements within the scope of ASC 606, the Company performs the following five steps: (i) identification of the contract with a customer; (ii) identification of the performance obligations in the contract; (iii) determination of the transaction price; (iv) allocation of the transaction price to the separate performance obligations in the contract; and (v) recognition of the revenue associated with performance obligations as they are satisfied. The Company applies the five-step model to contracts when it is probable that the Company will collect the consideration it is entitled to in exchange for the goods or services it transfers to the customer. At contract inception, once the contract is determined to be within the scope of ASC 606, the Company assesses the goods or services promised within each contract and determines those that are performance obligations, and assesses whether each promised good or service is distinct. If the contract contains a single performance obligation, the entire transaction price is allocated to the single performance obligation. Contracts that contain multiple performance obligations require an allocation of the transaction price based on the estimated relative standalone-selling prices of the promised products or services underlying each performance obligation. The Company determines standalone-selling prices based on the price at which the performance obligation is sold separately. If the standalone-selling price is not observable through past transactions, the Company estimates the standalone-selling price taking into account available information such as market conditions and internally approved pricing guidelines related to the performance obligations. The Company then recognizes as revenue the amount of the transaction price that is allocated to the respective performance obligation when (or as) the performance obligation is satisfied.

When determining the transaction price of a contract, an adjustment is made if payment from a customer occurs either significantly before or significantly after performance, resulting in a significant financing component. Applying the practical expedient in paragraph ASC 606-10-32-18, the Company does not assess whether a significant financing component exists if the period between when the Company performs its obligations under the contract and when the customer pays is one year or less. The Company did not have any contracts outstanding at January 1, 2018 and did not enter into any contracts during each of the years ended December 31, 2019 and 2018 that contained a significant financing component.

The Company records deferred revenue for product sales when (i) the Company has delivered products but other revenue recognition criteria have not been satisfied or (ii) payments have been received in advance of the completion of required performance obligations.

Shipping and Handling Costs

Shipping and handling costs associated with outbound freight after control over a product has transferred to a customer are accounted for as fulfillment costs and are included in the cost of product revenue. The amount of revenue recognized reflects the consideration to which the Company expects to be entitled to receive in exchange for these products or research services.

Product Revenue

The Company generally enters into contracts containing one type of performance obligation. The Company recognizes product revenue when the performance obligation is satisfied, which is generally upon delivery according to contractual shipping terms within customer purchase orders.

The Company also enters into rebate agreements with certain customers. These agreements may be considered an additional performance obligation of the Company or variable consideration within a contract. Rebates are recorded as a reduction of revenue in the period the related product revenue is recognized. A corresponding liability is recorded as a component of deferred revenue on the consolidated balance sheets. These arrangements are primarily based on the customer attaining contractually specified sales volumes.

The Company estimates the amount of its product sales that may be returned by its customers and records this estimate as a reduction of revenue in the period the related product revenue is recognized. The Company currently estimates product return liabilities using historical rates of return, current quarter credit sales, and specific items of exposure on a contract-by-contract basis. Sales return reserves were approximately $0.1 million at both December 31, 2019 and December 31, 2018.

Subsea Projects

The Company manufactures and sells subsea products that are designed for pipe-in-pipe applications in offshore oil production and are typically customized to meet customer specifications. Subsea products typically have no alternative use and contain an enforceable right to payment. Customer invoicing terms for subsea products are typically based on certain milestones within the production and delivery schedule. Under the provisions of ASC 606, the Company recognizes revenue at a point in time when transfer of control of the products is passed to the customer, or over time utilizing the input/cost-to-cost method. The timing of revenue recognition is assessed on a contract-by-contract basis. During the years ended December 31, 2019 and 2018, the Company recognized revenue of $17.0 million and $8.1 million, respectively, in connection with subsea projects.

Research Services

The Company performs research services under contracts with various government agencies and other institutions. These contracts generally have one type of performance obligation associated with the provision of research services including functional licenses to any resulting intellectual property. The Company records revenue using the percentage-of-completion method in two ways: (1) for firm-fixed-price contracts, the Company accrues that portion of the total contract price that is allocable on the basis of the Company’s estimates of costs incurred to date to total contract costs; and (2) for cost-plus-fixed-fee contracts, the Company records revenue that is equal to total payroll cost incurred times a stated factor plus reimbursable expenses, to a stated upper limit. The primary cost under the Company’s research service contracts is the labor effort expended in completing the research. Typically, the only deliverable, other than the labor hours expended, is reporting research results to the customer or delivery of research grade aerogel products. Because the input measure of labor hours expended is also reflective of the output measure, it is a reliable means to measure the extent of progress toward completion. Revisions in cost estimates and fees during the course of the contract are reflected in the accounting period in which the facts that require the revisions become known. Contract costs and rates used to allocate overhead to contracts are subject to audit by the respective contracting government agency. Adjustments to revenue as a result of audit are recorded within the period they become known. To date, adjustments to revenue as a result of contracting agency audits have been insignificant.

Disaggregation of Revenue

In the following table, revenue is disaggregated by primary geographical region and source of revenue:

	Year Ended December 31,					
	2019			2018		
	U.S.	International	Total	U.S.	International	Total
	(In thousands)					
Geographical region						
Asia	$ —	$ 44,485	$ 44,485	$ —	$ 34,597	$ 34,597
Canada	—	9,064	9,064	—	4,749	4,749
Europe	—	24,081	24,081	—	19,905	19,905
Latin America	—	3,417	3,417	—	3,377	3,377
U.S.	58,328	—	58,328	41,733	—	41,733
Total revenue	$ 58,328	$ 81,047	$ 139,375	$ 41,733	$ 62,628	$ 104,361
Source of revenue						
Product revenue	$ 52,050	$ 67,856	$ 119,906	$ 39,490	$ 54,487	$ 93,977
Subsea projects	3,837	13,191	17,028	5	8,141	8,146
Research services	2,441	—	2,441	2,238	—	2,238
Total revenue	$ 58,328	$ 81,047	$ 139,375	$ 41,733	$ 62,628	$ 104,361

Contract Balances

The following table presents changes in the Company's contract assets and contract liabilities during the year ended December 31, 2019:

	Balance at December 31, 2018	Additions	Deductions	Balance at December 31, 2019
	(In thousands)			
Contract assets				
Subsea projects	$ 2,742	$ 16,760	$ (16,691)	$ 2,811
Research services	369	2,045	(2,242)	172
Total contract assets	$ 3,111	$ 18,805	$ (18,933)	$ 2,983
Contract liabilities				
Deferred revenue				
Product revenue	$ 1,751	$ 8,907	$ (5,667)	$ 4,991
Subsea projects	781	9,795	(10,085)	491
Research services	97	212	(171)	138
Prepayment liability	4,485	5,389	(88)	9,786
Total contract liabilities	$ 7,114	$ 24,303	$ (16,011)	$ 15,406

During the year ended December 31, 2019, the Company recognized $2.1 million of revenue that was included in deferred revenue at the beginning of the period.

A contract asset is recorded when the Company satisfies a performance obligation by transferring a promised good or service and has earned the right to consideration from its customer. These assets may represent a conditional or unconditional right to consideration and are included within accounts receivable on the consolidated balance sheets.

A contract liability is recorded when consideration is received, or such consideration is unconditionally due, from a customer prior to transferring goods or services under the terms of the contract. Contract liabilities are recognized as revenue after control of the products or services is transferred to the customer and all revenue recognition criteria have been met.

Transition Disclosures

There was no difference in the accounting for revenue transactions under ASC 606 or ASC 605 for the year ended December 31, 2017. The following tables summarize the impacts of adopting ASC 606 on certain components of the Company's consolidated financial statements for the year ended December 31, 2018:

Consolidated Statements of Operations

	Year Ended December 31, 2018	
	As reported under ASC 606	Pro forma as if ASC 605 was in effect
	(In thousands)	
Product revenue	$ 102,123	$ 98,993
Total revenue	104,361	101,231
Product cost of revenue	90,660	87,406
Gross profit	12,669	12,793
Loss from operations	(33,916)	(33,792)
Net loss	(34,440)	(34,316)

Total reported product revenue and product cost of revenue as reported under ASC 606 were approximately $3.1 million and $3.3 million, respectively, greater than the pro forma consolidated statement of operations as if ASC 605 was in effect for the year ended December 31, 2018. Reported revenue and cost of revenue reflect the impact of revenue recognized over time utilizing the input/cost-to-cost method for subsea projects during the year ended December 31, 2018. Under ASC 605 subsea projects revenue was recognized at a point in time when transfer of control of the product passed to the customer.

The impact of the adoption of ASC 606 on the consolidated statement of cash flows for the year ended December 31, 2018 was not material and had no impact on net cash used in operating activities.

(4) Inventories

Inventories consist of the following:

	December 31,	
	2019	2018
	(In thousands)	
Raw material	$ 4,334	$ 3,159
Finished goods	4,434	4,159
Total	$ 8,768	$ 7,318

(5) Property, Plant and Equipment, Net

Property, plant and equipment consist of the following:

	December 31,		
	2019	2018	Useful life
	(In thousands)		
Construction in progress	$ 1,309	$ 1,568	—
Buildings	24,016	24,016	30 years
Machinery and equipment	122,485	120,466	3 — 10 years
Computer equipment and software	8,556	8,352	3 years
Total	156,366	154,402	
Accumulated depreciation and amortization	(102,749)	(92,703)	
Property, plant and equipment, net	$ 53,617	$ 61,699	

Depreciation expense was $10.2 million, $10.8 million and $10.8 million for the years ended December 31, 2019, 2018 and 2017, respectively. Amortization associated with assets under capital leases was less than $0.1 million for the year ended December 31, 2017. The Company had no assets under capital leases during the years ended December 31, 2019 and 2018.

Construction in progress totaled $1.3 million and $1.6 million at December 31, 2019 and 2018, respectively. Construction in progress included $0.1 million and $1.2 million at December 31, 2019 and 2018, respectively, related to projects associated with the Company's plan to expand the capacity of the East Providence, Rhode Island facility.

During 2016, the Company had previously completed the design and engineering for a second manufacturing facility to be located in Statesboro, Georgia. At that time, the Company elected to delay construction of the facility due to its assessment of future demand. In December 2018, the Company determined that due to its cumulative manufacturing process advancements since 2016 and expected additional improvements in the near, it would not use the existing design and engineering to construct a second facility in any location. Accordingly, the Company determined that the design and engineering costs were not recoverable and recorded an impairment charge of $7.4 million on construction in progress assets during 2018.

(6) Accrued Expenses

Accrued expenses consist of the following:

	December 31,	
	2019	2018
	(In thousands)	
Employee compensation	$ 6,472	$ 2,750
Other accrued expenses	1,585	1,114
Total	$ 8,057	$ 3,864

(7) Revolving Line of Credit

The Company is party to an Amended and Restated Loan and Security Agreement with Silicon Valley Bank (Loan Agreement). On March 3, 2020, the Loan Agreement was amended to extend the maturity date of the revolving credit facility to April 28, 2021.

Under the revolving credit facility, the Company is permitted to borrow a maximum of $20.0 million, subject to continued covenant compliance and borrowing base requirements. At the Company's election, the interest rate applicable to borrowings under the revolving credit facility may be based on prime rate or LIBOR. Prime rate-based rates vary from prime rate plus 0.75% per annum to prime rate plus 2.00% per annum, while LIBOR-based rates vary from LIBOR plus 3.75% per annum to LIBOR plus 4.25% per annum. In addition, the Company is required to pay a monthly unused revolving line facility fee of 0.5% per annum of the average unused portion of the revolving credit facility.

Under the Loan Agreement, the Company is required to comply with both non-financial and financial covenants, including a minimum EBITDA covenant, as defined. At December 31, 2019, the Company was in compliance with all such covenants. Obligations under the Loan Agreement are secured by a security interest in all assets of the Company, including those at the East Providence facility, except for certain exclusions. The Company intends to extend or replace the facility prior to its maturity.

During the year ended December 31, 2019, the Company borrowed $125.8 million and repaid $126.9 million under the line of credit. At December 31, 2019 and 2018, the Company had $3.1 million and $4.2 million drawn on the revolving credit facility.

The Company has been required to provide letters of credit to secure obligations under certain commercial contracts and other obligations. The Company had outstanding letters of credit backed by the revolving credit facility of $0.9 million and $1.6 million at December 31, 2019 and 2018, respectively, which reduce the funds otherwise available to the Company under the facility.

At December 31, 2019, the amount available to the Company under the revolving credit facility was $12.4 million after giving effect to the $3.1 million in outstanding borrowings and $0.9 million of outstanding letters of credit.

(8) Interest Expense, net

For the years ended December 31, 2019, 2018, and 2017, interest expense, net was $0.4 million, $0.5 million, and $0.2 million, respectively, and consisted primarily of fees and interest expense related to the Company's revolving credit facility with Silicon Valley Bank.

(9) Leases

The Company leases office and warehouse space in Northborough, Massachusetts and East Providence, Rhode Island under operating leases. Under these agreements, the Company is obligated to pay annual rent, real estate taxes, and certain other operating expenses. The Company also leases equipment under operating leases. The Company's operating leases expire at various dates through 2026.

On January 1, 2019, the Company adopted ASU 2016-02 which modifies the accounting for leases and requires that all leases be recorded on the consolidated balance sheets as assets and liabilities. The Company adopted this standard using the modified retrospective transition approach with the effective date as the date of initial application. As a result, the Company did not update financial information or provide the disclosures otherwise required under the new standard for dates and periods before January 1, 2019. The Company also elected the package of practical expedients under the new standard, which permits the Company to not reassess prior conclusions about lease identification, lease classification, and initial direct costs. In addition, the Company elected the short-term lease recognition exemption under which the Company will not recognize ROU assets or lease liabilities for all leases that qualify. The Company also elected the practical expedient to not separate non-lease components from the associated lease components for all of its equipment leases.

The Company determines if an arrangement is a lease at inception. ROU assets represent the Company's right to use an underlying asset for the lease term and lease liabilities represent the Company's payment obligations under the lease. Operating lease ROU assets and liabilities are recognized based on the present value of lease payments over the lease term. To measure its lease liabilities, the Company uses its incremental borrowing rate or the rate implicit in the lease, if available. The Company calculates its incremental borrowing rate using a synthetic credit rating analysis based on Moody's Building Materials Industry Rating Methodology. ROU assets also include any direct costs and prepaid lease payments but exclude any lease incentives received. The Company's lease terms may include options to extend or terminate the lease when it is reasonably certain that the Company will exercise that option. Lease expense for lease payments is recognized on a straight-line basis over the lease term.

The Company elected the short-term lease recognition exemption for all leases that qualify. For leases that qualify for this exemption, the Company does not recognize ROU assets or lease liabilities. For lease agreements with lease and non-lease components, the Company accounts for each component separately. However, in the case of equipment leases, the Company accounts for lease and non-lease components as a single component.

Prior to the Company's adoption of ASU 2016-02, the Company recorded the difference between rent expense recognized on a straight-line basis and the contractual payments as deferred rent. Deferred rent consisted of the following at December 31, 2018:

	December 31, 2018 (In thousands)
Deferred rent	$ 1,368
Current maturities of deferred rent	(150)
Deferred rent, less current maturities	$ 1,218

Upon adoption of ASU 2016-02 on January 1, 2019, the Company recognized operating lease liabilities of approximately $6.0 million with corresponding ROU assets of approximately $4.6 million. Additionally, the Company derecognized deferred rent liabilities of $1.4 million. Maturities of operating lease liabilities at December 31, 2019 are as follows:

Year	Operating Leases (In thousands)
2020	1,413
2021	1,221
2022	1,138
2023	1,105
2024	651
Thereafter	1,048
Total lease payments	6,576
Less imputed interest	(1,246)
Total lease liabilities	$ 5,330

The Company incurred operating lease costs of $1.5 million during the year ended December 31, 2019. Cash payments related to operating lease liabilities were $1.4 million during the year ended December 31, 2019. At December 31, 2019, the weighted average remaining lease term for operating leases was 5.4 years. At December 31, 2019, the weighted average discount rate for operating leases was 7.9%.

As of December 31, 2019, the Company has additional operating equipment leases with total lease payments of $0.4 million that have not commenced. These operating leases will commence during fiscal year 2020 and have a weighted average lease term of 3.80 years.

Transition Disclosures

The Company adopted ASU 2016-02 using the modified retrospective transition approach with the effective date as the date of initial application. As a result, the Company did not update financial information or provide the disclosures otherwise required under the new standard for dates and periods before January 1, 2019. Accordingly, the Company must present the disclosures that were required prior to the Company’s adoption of ASU 2016-02.

Future minimum lease payments under operating leases at December 31, 2018 were as follows:

Year	Operating Leases (In thousands)
2019	$ 1,375
2020	1,304
2021	1,124
2022	1,068
2023	1,082
Thereafter	1,701
Total minimum lease payments	$ 7,654

(10) Commitments and Contingencies

Operating Leases

During 2016, the Company entered into an agreement to extend its lease of approximately 51,650 square feet of office space in Northborough, Massachusetts. The lease commenced on January 1, 2017 and will expire on December 31, 2026. The annual base rent associated with the lease was $408,000 during 2017 and will increase by approximately 3% annually for the term of the lease. The lease also requires the payment by the Company of its pro rata share of real estate taxes and certain other expenses. Prior to the expiration of the lease, the Company will have the right to extend the lease for an additional term of three years.

Under the terms of the lease extension, the landlord provided the Company with an allowance of $1.2 million to be utilized for improvements to the leased premises. These amounts were considered a lease incentive and were excluded from the Company’s ROU assets upon its adoption of ASU 2016-02 on January 1, 2019 (see note 9). At December 31, 2018, these amounts are recorded as a component of deferred rent on the consolidated balance sheets. At December 31, 2019 and 2018, the Company had capitalized $1.2 million in associated leasehold improvement costs.

The Company also leases facilities and equipment under operating leases expiring at various dates through 2024. Under these agreements, the Company is obligated to pay annual rent, real estate taxes, and certain operating expenses. See note 9 for further information on future minimum lease payments under operating leases at December 31, 2019.

The Company incurred rent expense under all operating leases of approximately $1.5 million, $1.5 million and $1.4 million in the years ended December 31, 2019, 2018 and 2017, respectively.

Letters of Credit

The Company has been required to provide certain customers with letters of credit securing obligations under commercial contracts. The Company had letters of credit outstanding of $0.9 million and $1.6 million at December 31, 2019 and 2018, respectively. These letters of credit are secured by the Company's revolving credit facility (see note 7).

Customer Supply Agreement

The Company is party to a supply agreement, as amended, with BASF Polyurethanes GmbH (BASF) (the Supply Agreement) and a joint development agreement with BASF SE (the JDA). Pursuant to the Supply Agreement, the Company will sell exclusively to BASF certain of the Company's products at annual volumes to be specified by BASF, subject to certain volume limits. However, BASF has no obligation to purchase products under the Supply Agreement. The Supply Agreement will terminate on December 31, 2027 with respect to the Company's Spaceloft A2 product and December 31, 2028 with respect to a new product developed under the JDA. Upon the expiration of the Supply Agreement with respect to each product, the Company will be subject to a post-termination supply commitment for an additional two years. The JDA is designed to facilitate collaboration by the parties on the development and commercialization of new products.

In addition, BASF, in its sole discretion, may make prepayments to the Company in the aggregate amount of up to $22.0 million during the term of the Supply Agreement. These prepayment obligations are secured by a security interest in real estate, plant and equipment at the Company's Rhode Island facility and a license to certain intellectual property. BASF made a prepayment in the amount of $5.0 million to the Company in 2018 (the 2018 Prepayment). Beginning January 1, 2019, BASF may require that the Company credit up to 25.3% of any amounts invoiced by the Company for Spaceloft A2 product sold to BASF against the 2018 Prepayment balance. If any of the 2018 Prepayment remains uncredited as of December 31, 2021, BASF may require that the Company repay the uncredited amount to BASF.

Pursuant to the first addendum to the Supply Agreement, on January 30, 2019, BASF made an additional prepayment in the amount of $5.0 million to the Company (the 2019 Prepayment). After January 1, 2020, the Company will credit 50.0% of any amounts that it invoices for the newly developed product sold to BASF against the outstanding balance of the 2019 Prepayment. After December 31, 2022, BASF may require that the Company credit an additional 24.7% of any amounts invoiced by the Company for Spaceloft A2 product sold to BASF against the outstanding balance of the 2019 Prepayment, if any, or may require that the Company repay the uncredited amount of the 2019 Prepayment to BASF in full.

As of December 31, 2019, the Company had received $10.0 million in prepayments from BASF and applied less than $0.1 million of credits against amounts invoiced. The prepayments are recorded on the balance sheet as a prepayment liability, net of the current portion of $0.2 million and $0.5 million at December 31, 2019 and 2018, respectively, which is included within deferred revenue. The amounts and terms of additional prepayment installments, if any, are subject to negotiation between the Company and BASF.

Litigation

The Company is, from time to time, a party to litigation that arises in the normal course of its business operations. See Part I, Item 3 ("Legal Proceedings") of this Annual Report on Form 10-K for a description of certain of the Company's current legal proceedings. The Company is not presently a party to any litigation for which it believes a loss is probable requiring an amount to be accrued or a possible loss contingency requiring disclosure.

(11) Stockholders' Equity

At December 31, 2019 and 2018, the Company was authorized to issue 130,000,000 shares of stock, of which 125,000,000 shares were designated as common stock and 5,000,000 shares were designated as preferred stock.

(12) Employee Benefit Plan

The Company sponsors the Aspen Aerogels, Inc. 401(k) Plan. Under the terms of the plan, the Company's employees may contribute a percentage of their pretax earnings. During each of the years ended December 31, 2019, 2018 and 2017, the Company provided matching contributions of $0.2 million.

(13) Employee Stock Ownership Plans

Effective June 12, 2014, the Company adopted the 2014 Employee, Director and Consultant Equity Incentive Plan (the 2014 Equity Plan). Under the 2014 Equity Plan, the Company may grant incentive stock options (ISOs), non-qualified stock options (NSOs), restricted stock, restricted stock units (RSUs) and other stock-based awards. Stock options under the plan are to be granted with an exercise price not less than the fair market value of the Company's common stock at the date of grant. Equity awards granted to employees generally vest over a service period of three to four years. Restricted stock and stock options granted to nonemployee directors generally vest over a one year service period.

During 2019, the Company granted 50,328 shares of restricted common stock with a grant date fair value of $0.3 million and NSOs to purchase 71,700 shares of common stock with a grant date fair value of $0.2 million vesting over a period of one year to its non-employee directors under the 2014 Equity Plan.

During 2019, the Company granted 661,263 RSUs with a grant date fair value of $2.4 million and NSOs to purchase 632,183 shares of common stock with a grant date fair value of $1.1 million to employees under the 2014 Equity Plan. The RSUs and NSOs granted to employees will vest over a three-year period.

During 2019, the Company also granted NSOs to purchase 20,000 shares of common stock under the 2014 Equity Plan to an outside consultant which will vest on March 26, 2020 with a grant date fair value of less than $0.1 million.

On December 11, 2015, the Company issued certain equity grants to its chief executive officer which included 78,125 shares of restricted stock, NSOs to purchase 84,745 shares of common stock vesting solely over three years and NSOs to purchase 370,181 shares of common stock vesting subject to certain common stock price target achievements, as defined, over a three to five year period (the CEO Options). Collectively, these equity grants had an aggregate fair value of $2.0 million at the time of grant. The restricted stock award will vest based on achievement of a Company financial performance target for fiscal year 2020.

On August 2, 2017, the Company modified the performance target for the year ending December 31, 2020 with respect to 78,125 shares of restricted stock held by its chief executive officer. In addition, the Company modified the vesting conditions of NSOs to purchase 131,578 and 122,324 shares of common stock held by its chief executive officer to extend the time period to achieve certain common stock price targets by an additional year to four and five years from the date of grant, respectively.

The Company accounted for the extension of the time periods for the achievement of the common stock price target vesting conditions of the NSOs as modifications in determining the stock-based compensation expense to be recognized over the remaining service period. The total incremental compensation expense resulting from the modification was $0.1 million. The incremental compensation expense associated with these awards will be recognized over the remaining service period of the awards.

On November 7, 2018, the Company modified the vesting conditions of the CEO Options such that in the event of a change in control, all the outstanding NSOs would vest, regardless of whether or not the common stock price target vesting conditions of the NSOs are achieved. The total incremental compensation expense resulting from the modification was approximately $0.1 million which will be recognized over the remaining term of the options.

Stock-based compensation is included in cost of sales or operating expenses, as applicable, and consists of the following:

	Year Ended December 31,		
	2019	2018	2017
	(In thousands)		
Cost of product revenue	$ 573	$ 577	$ 790
Research and development expenses	506	461	555
Sales and marketing expenses	629	815	1,096
General and administrative expenses	2,063	2,449	2,650
Total stock-based compensation	$ 3,771	$ 4,302	$ 5,091

At December 31, 2019, 4,544,989 shares of common stock were reserved for issuance upon the exercise or vesting, as appropriate, of outstanding stock-based awards granted under the 2014 Equity Plan. In addition, at December 31, 2019, 85,445 shares of common stock were reserved for issuance upon the exercise of outstanding options granted under the Company's 2001 Equity Incentive Plan, as amended (the 2001 Equity Plan). Any cancellations or forfeitures of the options outstanding under the 2001 Equity Plan will result in the shares reserved for issuance upon exercise or such options becoming available for grant under the 2014 Equity Plan. At December 31, 2019, the Company has either issued or reserved in connection with statutory tax withholdings a total of

1,785,968 shares under the 2014 Equity Plan. At December 31, 2019, there were 1,072,528 shares available for future grant under the 2014 Equity Plan.

Stock Options Valuation and Amortization Method

The fair value of each stock option is estimated as of the date of grant using the Black-Scholes option pricing model. Key inputs into this formula included expected term, expected volatility, expected dividend yield and the risk-free rate. Each assumption is set forth and discussed below.

The Company used a Monte Carlo Simulation model to estimate the original grant date fair value of the CEO Options as well as the 2017 and 2018 modifications. The simulation model was based on the Black-Scholes option pricing model and a number of complex assumptions including (i) whether the vesting condition is satisfied within the time-vesting periods, and (ii) the date the common stock price target is met per the terms of the agreement.

For stock options with a service condition, the fair value is amortized on a straight-line basis over the requisite service period of the options, which is generally a three-year vesting period from the date of grant.

Expected Term

The expected term represents the period that the Company's stock-based awards are expected to be outstanding. The Company does not have sufficient historical exercise data to provide a reasonable basis upon which to estimate the expected term. Accordingly, the Company uses the simplified method to calculate the expected term for options granted.

Expected Volatility

Due to the Company's limited historical data, the Company's uses an estimated volatility based on the historical volatility of comparable companies with publicly available share prices. In 2019, 2018 and 2017, the expected volatility is based on the weighted average volatility of up to 17 companies with business, financial and market attributes that the Company believes are similar to its own.

Expected Dividend

The Company uses an expected dividend yield of zero. The Company does not intend to pay cash dividends on its common stock in the foreseeable future, nor has it paid dividends on its common stock in the past.

Risk-free Interest Rate

The Company uses a risk-free interest rate based on U.S. Treasury zero-coupon issues with a remaining term equal to the expected life assumed at the date of grant.

Estimated Forfeitures

Effective January 1, 2017, the Company adopted the provisions of ASU 2016-09 related to the timing of accounting for the forfeitures of share based awards using a modified retrospective transition method. Under these provisions, the Company records the impact of forfeitures of service based awards at the time an award is forfeited. Adoption of the provisions resulted in a cumulative-effect adjustment to equity as of January 1, 2017 of $0.3 million.

Assumptions Utilized

The following information relates to the fair value of the option awards estimated by use of the Black-Scholes option pricing model:

	Year Ended December 31, 2019	2018	2017
Weighted average assumptions:			
Expected term (in years)	5.81	5.93	5.86
Expected volatility	49.90%	47.68%	51.95%
Risk free rate	2.44%	2.76%	1.99%
Expected dividend yield	0.00%	0.00%	0.00%
Weighted average fair value:			
Grant-date fair value of options granted	$ 1.90	$ 2.29	$ 2.08
Grant-date fair value of options vested	$ 2.24	$ 3.29	$ 3.98
Aggregate intrinsic value of options exercised	$ —	$ —	$ —

Outstanding Options

The following table summarizes information about stock options outstanding:

	Number of Shares	Weighted Average Grant Date Fair Value Per Share	Weighted Average Exercise Price Per Share	Weighted Average Remaining Contractual Term (Years)	Aggregate Intrinsic Value
		($ in thousands, except share and per share data)			
Options outstanding at December 31, 2018	2,994,452	$ 6.22	$ 9.34	7.11	$ —
Granted	723,883	$ 1.90	$ 3.94		
Forfeited	(155,991)	$ 5.23	$ 8.73		
Expired	(14,910)	$ 11.78	$ 15.45		
Exercised	—	$ —	$ —		$ —
Options outstanding at December 31, 2019	3,547,434	$ 5.36	$ 8.13	6.74	$ 7,908,311
Exercisable at December 31, 2019	2,149,317	$ 7.38	$ 10.17	5.84	$ 3,403,281
Expected to vest at December 31, 2019	1,398,117	$ 2.25	$ 4.54	1.60	$ 4,505,030

As of December 31, 2019, total unrecognized compensation cost related to non-vested service-based options granted under the 2014 Equity Plan was $1.6 million. The unrecognized compensation cost for the service-based options is expected to be recognized over a weighted average period of 1.60 years.

Restricted Stock Awards and Restricted Stock Units

The Company values restricted stock awards and RSUs based on the closing price of our shares on the date of grant. RSUs have time-based vesting conditions and typically vest over three or four years. Restricted stock awards issued to nonemployee directors generally vest in full one year from the date of grant.

Information related to grants of RSUs during 2019 is as follows:

	Restricted Stock Units	Weighted Average Grant Date Fair Value
Balance at December 31, 2018	875,227	$ 4.38
Granted	661,263	3.70
Vested	(411,844)	4.30
Forfeited	(41,646)	4.07
Balance at December 31, 2019	1,083,000	$ 4.01

Restricted stock awards granted during 2019 are considered issued and outstanding common stock and are excluded from the table above. As of December 31, 2019 there were 128,453 shares of restricted stock outstanding.

The total intrinsic value of restricted stock and RSUs that vested in 2019 and 2018 was $1.5 million and $0.8 million, respectively. As of December 31, 2019, 1,133,328 of the total shares of restricted stock and RSUs outstanding will vest upon the fulfillment of service conditions. In addition, 78,125 shares of restricted stock will vest only if a certain performance condition is achieved. As of December 31, 2019, the Company has recorded $0.1 million in compensation expense to date in connection with the award.

As of December 31, 2019, total unrecognized compensation cost related to restricted stock awards of $0.2 million, RSUs of $2.7 million and restricted stock with performance-based conditions of less than $0.1 million is expected to be recognized over a weighted average period of 0.47 years, 1.80 years and 1.00 year, respectively.

(14) Net Loss Per Share

The computation of basic and diluted net loss per share consists of the following:

	Year ended December 31,		
	2019	2018	2017
	(In thousands, except share and per share data)		
Numerator:			
Net loss	$ (14,565)	$ (34,440)	$ (19,321)
Denominator:			
Weighted average shares outstanding, basic and diluted	24,099,438	23,738,852	23,390,235
Net loss per share, basic and diluted	$ (0.60)	$ (1.45)	$ (0.83)

On February 18, 2020, the Company completed an underwritten public offering 1,955,000 shares of its common stock at an offering price of $8.25 per share.

Potentially dilutive common shares that were excluded from the computation of diluted net loss per share because they were anti-dilutive consist of the following:

	Year ended December 31,		
	2019	2018	2017
Common stock options	3,547,434	2,994,452	2,432,906
Restricted common stock units	1,083,000	875,227	827,391
Restricted common stock awards	128,453	136,187	151,859
Total	4,758,887	4,005,866	3,412,156

In the table above, anti-dilutive shares consist of those common stock equivalents that have (i) an exercise price above the average stock price for the period or (ii) related average unrecognized stock compensation expense sufficient to buy back the entire amount of shares. The Company excludes the shares issued in connection with restricted stock awards from the calculation of basic weighted average common shares outstanding until the restrictions lapse.

For each of the years ended December 31, 2019, 2018 and 2017, there was no dilutive impact of the common stock options, RSUs, and restricted stock awards.

(15) Income Taxes

The Company incurred net operating losses and recorded a full valuation allowance against net deferred assets for all periods presented. Accordingly, the Company has not recorded a provision for federal or state income taxes.

The reconciliation between the U.S. statutory income tax rate and the Company’s effective rate consists of the following:

	Year Ended December 31,		
	2019	2018	2017
U.S. federal income tax statutory rate	21%	21%	35%
Permanent differences	(2)%	—%	(3)%
State tax, net of federal benefit	—%	2%	(5)%
Changes in valuation allowance for deferred tax assets	(18)%	(22)%	113%
Stock-based compensation	(1)%	—%	—%
2017 Tax Cuts and Jobs Act	—%	—%	(138)%
Other	—%	(1)%	(2)%
Effective tax rate	—	—	—

The tax effects of temporary differences between financial statement and tax accounting that gave rise to significant portions of the Company’s deferred tax assets and deferred tax liabilities at December 31, 2019 and 2018 are presented below:

	December 31,	
	2019	2018
	(In thousands)	
Deferred tax assets:		
Net operating loss carryforwards	$ 53,859	$ 51,629
Stock-based compensation	5,261	5,194
Operating lease liabilities	1,356	—
Tax credit carryforwards	289	296
Reserves and accruals	423	1,258
Interest expense limitation	235	135
Intangible assets and amortization	—	50
Total gross deferred tax assets	61,423	58,562
Deferred tax liabilities:		
Depreciation	(3,883)	(4,614)
Operating lease right-of-use assets	(1,025)	—
Total deferred tax liabilities	(4,908)	(4,614)
Total deferred tax assets and liabilities	56,515	53,948
Valuation allowance	(56,515)	(53,948)
Net deferred tax asset	$ —	$ —

On December 22, 2017, the President of the United States signed into law the Tax Cuts and Jobs Act (TCJA) tax reform legislation. This legislation makes significant change in U.S. tax law including a reduction in the corporate tax rates, changes to net operating loss carryforwards and carrybacks, and a repeal of the corporate alternative minimum tax. The legislation reduced the U.S. corporate tax rate from 34% to 21% for the years ending December 31, 2019 and 2018. As a result of the enacted law, the Company was required to revalue deferred tax assets and liabilities at the 21% rate as of December 31, 2017. This resulted in a decrease in the Company’s net deferred tax asset and corresponding valuation allowance of $26.7 million. As the Company maintains a full valuation allowance against its net deferred tax asset position in the United States, this revaluation did not result in an income tax expense or benefit during the year ending December 31, 2017. The provisions of the TCJA related to the one-time mandatory transition tax on deemed repatriation did not have an impact on the Company’s results of operations during each of the years ended December 31, 2019, 2018, and 2017. The other provisions of the TCJA did not have a material impact on the Company’s 2019, 2018, or 2017 consolidated financial statements.

The Company is subject to additional requirements of the TCJA which became effective during the year ended December 31, 2018. The change in tax law allows post-2017 federal net operating losses to be carried forward indefinitely and allows such net operating losses to offset up to 80% of future taxable income. The Company is also subject to the rules regarding global intangible low-taxed income (“GILTI”), which the Company has elected to account for as a period cost, the limitation on the deductibility of certain executive compensation and interest expense and other immaterial provisions.

The net change in the valuation allowance for the year ended December 31, 2019, was an increase of $2.6 million. The Company has recorded a full valuation allowance against its deferred tax assets due to the uncertainty associated with the utilization of the net operating loss carryforwards and other future deductible items. In assessing the realizability of deferred tax assets, the Company considers all available evidence, historical and prospective, with greater weight given to historical evidence, in determining whether it is more likely than not that some portion or all of the deferred tax assets will not be realized. The ultimate realization of the Company's deferred tax assets generally is dependent upon generation of future taxable income.

At December 31, 2019, the Company had $233.8 million of net operating losses available to offset future federal income, if any, of which $194.6 million expire on various dates through December 31, 2037. Net operating losses of $39.2 million generated during the years ended December 31, 2019 and 2018 have an unlimited carryforward.

At December 31, 2019, the Company has $81.4 million of apportioned net operating losses available to offset future state taxable income, if any, and which begin to expire at various dates between 2020 and 2039.

For each of the years ended December 31, 2019, 2018, and 2017, the Company did not have any material unrecognized tax benefits and thus no interest and penalties related to unrecognized tax benefits were recorded. In addition, the Company does not expect that the amount of unrecognized tax benefits will change significantly within the next twelve months.

The Company files a federal income tax return in the United States and income tax returns in various state and foreign jurisdictions. All tax years are open for examination by the taxing authorities for both federal and state purposes.

The Securities & Exchange Commission staff issued Staff Accounting Bulletin No. 118 (SAB 118) to address the tax reform legislation. In accordance with SAB 118, the Company has recognized the provisional tax impacts, outlined above, related to the re-measurement of its deferred income tax assets and liabilities associated with the one-time mandatory transition tax on deemed repatriation. The ultimate impact may differ from the provisional amounts, due to, among other things, the significant complexity of the 2017 Tax Act and anticipated additional regulatory guidance that may be issued by the IRS, changes in analysis, interpretations and assumptions the Company has made and actions the Company may take as a result of the 2017 Tax Act. The Company has completed its review of the 2017 Tax Act and noted no material changes to its initial assessment.

(16) Subsequent Events

The Company has evaluated subsequent events through March 6, 2020, the date of issuance of the consolidated financial statements for the year ended December 31, 2019.

On February 18, 2020, the Company completed an underwritten public offering 1,955,000 shares of its common stock at an offering price of $8.25 per share. The Company received net proceeds of $14.8 million after deducting underwriting discounts of $1.0 million and offering expenses of approximately $0.4 million.

On March 3, 2020, the Company's revolving credit facility with Silicon Valley Bank was amended to extend the maturity date of the facility to April 28, 2021. Pursuant to the amendment, the Company is permitted to borrow a maximum of $20.0 million, subject to continued covenant compliance and borrowing base requirements. At the Company's election, the interest applicable to borrowings under the revolving credit facility may be based on prime rate or LIBOR. Prime rate-based rates vary from prime rate plus 0.75% per annum to prime rate plus 2.00% per annum. While LIBOR-based rates vary from LIBOR plus 3.75% per annum to LIBOR plus 4.25% per annum. In addition, the Company is required to pay a monthly unused revolving line facility fee of 0.5% per annum of the average unused portion of the revolving credit facility. The amendment also established certain minimum required Adjusted EBITDA levels as a financial covenant for the extended term.

QUARTERLY RESULTS OF OPERATIONS

	Three Months Ended			
	March 31,	June 30,	Sept 30,	Dec 31,
	(in thousands, except per share data) (unaudited)			
2019				
Total revenue	$ 27,912	$ 29,533	$ 35,425	$ 46,505
Gross profit	3,718	3,514	7,742	11,310
Loss from operations	(5,961)	(5,215)	(2,153)	(830)
Net loss	(6,002)	(5,318)	(2,289)	(956)
Net loss per share basic and diluted common share - basic	$ (0.25)	$ (0.22)	$ (0.09)	$ (0.04)
2018				
Total revenue	$ 23,074	$ 21,671	$ 23,937	$ 35,679
Gross profit	2,810	2,744	1,529	5,586
Loss from operations	(6,750)	(6,855)	(6,369)	(13,942)
Net loss	(6,842)	(6,958)	(6,532)	(14,108)
Net loss per share basic and diluted common share - basic	$ (0.29)	$ (0.29)	$ (0.27)	$ (0.59)

Schedule II
VALUATION AND QUALIFYING ACCOUNTS
(in thousands)

Description	Balance at Beginning of Year	Charges to Costs and Expenses (a)	Recoveries of Costs and Expenses (b)	Deductions to Allowances for Uncollectible Accounts (c)	Charges to (Deductions from) Other Accounts (d)	Balance at End of Year
Year Ended December 31, 2019:						
Allowances for uncollectible accounts and sales returns and allowances	$ 2,877	—	(228)	(2,552)	47	$ 144
Year Ended December 31, 2018:						
Allowances for uncollectible accounts and sales returns and allowances	$ 93	2,961	(39)	(142)	4	$ 2,877
Year Ended December 31, 2017:						
Allowances for uncollectible accounts and sales returns and allowances	$ 93	—	—	—	—	$ 93

(a) Represents allowances for uncollectible accounts established through general and administrative expenses.

(b) Represents recoveries of allowances for uncollectible accounts established through general and administrative expenses.

(c) Represents actual write-offs of uncollectible accounts.

(d) Represents net change in allowances for sales returns, recorded as contra-revenue.

Item 9. **CHANGES IN AND DISAGREEMENTS WITH ACCOUNTANTS ON ACCOUNTING AND FINANCIAL DISCLOSURE**

Not applicable.

Item 9A. **CONTROLS AND PROCEDURES**

(a) *Evaluation of Disclosure Controls and Procedures*. We maintain disclosure controls and procedures that are designed to ensure that information required to be disclosed in the reports that we file or submit under the Securities Exchange Act of 1934, as amended, or the Exchange Act, is recorded, processed, summarized and reported within the time periods specified in the SEC's rules and forms and is accumulated and communicated to our management, including our principal executive officer and principal financial officer, or persons performing similar functions, as appropriate to allow timely decisions regarding required disclosure.

As of December 31, 2019, our management, with the participation of our principal executive officer and principal financial officer, evaluated the effectiveness of our disclosure controls and procedures (as defined in Rules 13a-15(e) and 15d-15(e) under the Exchange Act). Our management recognizes that any controls and procedures, no matter how well designed and operated, can provide only reasonable assurance of achieving their objectives, and management necessarily applies its judgment in evaluating the cost-benefit relationship of possible controls and procedures. Based on such evaluation, our principal executive officer and principal financial officer have concluded, that, as of December 31, 2019, our disclosure controls and procedures were effective to ensure that information required to be disclosed by us in the reports that we file or submit under the Exchange Act is recorded, processed, summarized and reported within the time periods specified in the SEC's rules and forms, and is accumulated and communicated to our management, including our principal executive officer and principal financial officer, or persons performing similar functions, as appropriate to allow timely decisions regarding required disclosure.

(b) *Management's Report on Internal Control over Financial Reporting*. The Company's management is responsible for establishing and maintaining adequate internal control over financial reporting. Internal control over financial reporting is defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act, as a process designed by, or under the supervision of, the Company's principal executive and principal financial officers and effected by the Company's board of directors, management and other personnel to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. The Company's internal control over financial reporting includes those policies and procedures that:

- pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the Company;
- provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the Company are being made only in accordance with authorizations of management and directors of the Company; and
- provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use or disposition of the Company's assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

The Company's management assessed the effectiveness of the Company's internal control over financial reporting as of December 31, 2019. In making this assessment, management used the criteria set forth by the Committee of Sponsoring Organizations of the Treadway Commission (COSO) in Internal Control-Integrated Framework (2013).

Based on our assessment, management believes that, as of December 31, 2019, the Company's internal control over financial reporting is effective based on those criteria.

Our independent registered public accounting firm has issued an audit report on our assessment of our internal control over financial reporting. This report appears further below in this Item 9A.

(c) *Changes in* Internal *Controls*. There were no changes in our internal control over financial reporting, as such term is defined in Rules 13a-15(f) and 15(d)-15(f) promulgated under the Exchange Act, identified in connection with the evaluation of such internal control that occurred during the fourth quarter of the last fiscal year that have materially affected, or are reasonably likely to materially affect, our internal control over financial reporting.

Report of Independent Registered Public Accounting Firm

To the Stockholders and Board of Directors
Aspen Aerogels, Inc.:

Opinions on the Consolidated Financial Statements and Internal Control Over Financial Reporting

We have audited the accompanying consolidated balance sheets of Aspen Aerogels, Inc. and subsidiaries (the Company) as of December 31, 2019 and 2018, the related consolidated statements of operations, stockholders' equity, and cash flows for each of the years in the three-year period ended December 31, 2019, and the related notes and financial statement schedule II – Valuation and Qualifying Accounts (collectively, the consolidated financial statements). We also have audited the Company's internal control over financial reporting as of December 31, 2019, based on criteria established in *Internal Control – Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission.

In our opinion, the consolidated financial statements referred to above present fairly, in all material respects, the financial position of the Company as of December 31, 2019 and 2018, and the results of its operations and its cash flows for each of the years in the three-year period ended December 31, 2019, in conformity with U.S. generally accepted accounting principles. Also in our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2019 based on criteria established in *Internal Control – Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission.

Change in Accounting Principle

As discussed in Note 2 to the consolidated financial statements, the Company has changed its method of accounting for leases as of January 1, 2019, in accordance with the adoption of Accounting Standards Codification (ASC) Topic 842, *Leases*.

Basis for Opinions

The Company's management is responsible for these consolidated financial statements, for maintaining effective internal control over financial reporting, and for its assessment of the effectiveness of internal control over financial reporting, included in the accompanying Management's Report on Internal Control over Financial Reporting. Our responsibility is to express an opinion on the Company's consolidated financial statements and an opinion on the Company's internal control over financial reporting based on our audits. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) (PCAOB) and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audits to obtain reasonable assurance about whether the consolidated financial statements are free of material misstatement, whether due to error or fraud, and whether effective internal control over financial reporting was maintained in all material respects.

Our audits of the consolidated financial statements included performing procedures to assess the risks of material misstatement of the consolidated financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the consolidated financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements. Our audit of internal control over financial reporting included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, and testing and evaluating the design and operating effectiveness of internal control based on the assessed risk. Our audits also included performing such other procedures as we considered necessary in the circumstances. We believe that our audits provide a reasonable basis for our opinions.

Definition and Limitations of Internal Control Over Financial Reporting

A company's internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company's internal control over financial reporting includes those policies and procedures that (1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (3) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Also, projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

/s/ KPMG LLP

We have served as the Company's auditor since 2002.

Hartford, Connecticut
March 6, 2020

Item 9B. OTHER INFORMATION

Amendment to SVB Credit Facility

On March 3, 2020, our revolving credit facility with Silicon Valley Bank was amended to extend the maturity date of the revolving credit facility to April 28, 2021. Under our revolving credit facility, we are permitted to borrow a maximum of $20.0 million, subject to continued covenant compliance and borrowing base requirements. At our election, the interest rate applicable to borrowings under the revolving credit facility may be based on the prime rate or LIBOR. Prime rate-based rates vary from prime rate plus 0.75% per annum to prime rate plus 2.00% per annum, while LIBOR-based rates vary from LIBOR plus 3.75% per annum to LIBOR plus 4.25% per annum. In addition, we are required to pay a monthly unused revolving line facility fee of 0.5% per annum of the average unused portion of the revolving credit facility. The credit facility has also been amended to establish certain minimum Adjusted EBITDA levels with respect to the minimum Adjusted EBITDA financial covenant for the extended term. We intend to extend or replace the facility prior to its maturity.

The foregoing description of the amendment to the credit facility is only a summary of its material terms and does not purport to be complete. This summary is qualified in its entirety by reference to the description of the amendment to the credit facility, a copy of which is filed as an exhibit as part of this Annual Report on Form 10-K.

PART III

Item 10. DIRECTORS, EXECUTIVE OFFICERS AND CORPORATE GOVERNANCE

The response to this item is incorporated by reference from the discussion responsive thereto under the captions "Management and Corporate Governance," "Delinquent Section 16(a) Reports," and "Code of Business Conduct and Ethics" in the Company's Proxy Statement for the 2020 Annual Meeting of Stockholders.

Item 11. EXECUTIVE COMPENSATION

The response to this item is incorporated by reference from the discussion responsive thereto under the caption "Executive Officer and Director Compensation" in the Company's Proxy Statement for the 2020 Annual Meeting of Stockholders.

Item 12. SECURITY OWNERSHIP OF CERTAIN BENEFICIAL OWNERS AND MANAGEMENT AND RELATED STOCKHOLDER MATTERS

The response to this item is incorporated by reference from the discussion responsive thereto under the captions "Security Ownership of Certain Beneficial Owners and Management," and "Equity Compensation Plan Information" in the Company's Proxy Statement for the 2020 Annual Meeting of Stockholders.

Item 13. CERTAIN RELATIONSHIPS AND RELATED TRANSACTIONS, AND DIRECTOR INDEPENDENCE

The response to this item is incorporated by reference from the discussion responsive thereto under the captions "Certain Relationships and Related Person Transactions" and "Management and Corporate Governance" in the Company's Proxy Statement for the 2020 Annual Meeting of Stockholders.

Item 14. PRINCIPAL ACCOUNTING FEES AND SERVICES

The response to this item is incorporated by reference from the discussion responsive thereto under the caption "Independent Registered Public Accounting Firm" in the Company's Proxy Statement for the 2020 Annual Meeting of Stockholders.

PART IV

Item 15. EXHIBITS, FINANCIAL STATEMENT SCHEDULES

Item 15(a). The following documents are filed as part of this Annual Report on Form 10-K:

Item 15(a)(1). The following consolidated financial statements of the Company are included in Part II, Item 8 of this Annual Report on Form 10-K:

Report of Independent Registered Public Accounting Firm
Consolidated Balance Sheets as of December 31, 2019 and 2018
Consolidated Statements of Operations for the Years Ended December 31, 2019, 2018, and 2017
Consolidated Statements of Stockholders' Equity for the Years Ended December 31, 2019, 2018 and 2017
Consolidated Statements of Cash Flows for the Years Ended December 31, 2019, 2018 and 2017
Notes to Consolidated Financial Statements

Item 15(a)(2). The following financial statements schedule is included in Part II, Item 8:

Schedule II – Valuation and Qualifying Accounts

All other financial statement schedules have not been included because they are not applicable or the information is included in the financial statements or notes thereto.

Item 15(a)(3). Exhibits:

The following is a list of exhibits filed as part of this Annual Report on Form 10-K.

Exhibit Number	Exhibit Description	Filed with this Report	Incorporated by Reference herein from Form or Schedule	Filing Date	SEC File/Reg. Number
3.1	Restated Certificate of Incorporation of the Registrant, as filed with the Secretary of State of the State of Delaware on June 18, 2014.		Form 8-K (Exhibit 3.2)	6/19/14	001-36481
3.2	Restated Bylaws of Aspen Aerogels, Inc.		Form 8-K (Exhibit 3.3)	6/19/14	001-36481
4.1	Form of common stock certificate.		Amendment No. 1 to Form S-1 (Exhibit 4.1)	5/14/14	333-195523
4.2	Sixth amended and restated registration rights agreement, dated as of June 11, 2012, by and among the Registrant and the investors named therein, as amended.		Form S-1 (Exhibit 4.8)	4/28/14	333-195523
4.3	Description of Securities.	X			
9.1	Letter agreement, dated as of June 11, 2014, by and between the Registrant and the Fidelity Funds.		Amendment No. 5 to Form S-1 (Exhibit 9.1)	6/12/14	333-195523
10.1	2001 equity incentive plan, as amended. +		Form S-1 (Exhibit 10.1.1)	4/28/14	333-195523
10.2	Form of incentive stock option agreement granted under 2001 equity incentive plan, as amended.+		Form S-1 (Exhibit 10.1.2)	4/28/14	333-195523

Exhibit Number	Exhibit Description	Filed with this Report	Incorporated by Reference herein from Form or Schedule	Filing Date	SEC File/Reg. Number
10.3	Form of 2013 incentive stock option agreement for options issued in exchange for the forfeiture of options granted under 2001 equity incentive plan, as amended.+		Form S-1 (Exhibit 10.1.3)	4/28/14	333-195523
10.4	Form of 2013 performance-based incentive stock option agreement granted under 2001 equity incentive plan, as amended.+		Form S-1 (Exhibit 10.1.4)	4/28/14	333-195523
10.5	Form of non-qualified stock option agreement granted under 2001 equity incentive plan, as amended.+		Form S-1 (Exhibit 10.1.5)	4/28/14	333-195523
10.6	Form of 2013 non-qualified stock option agreement for options issued in exchange for the forfeiture of options granted under 2001 equity incentive plan, as amended.+		Form S-1 (Exhibit 10.1.6)	4/28/14	333-195523
10.7	Form of 2013 performance-based non-qualified stock option agreement granted under 2001 equity incentive plan, as amended.+		Form S-1 (Exhibit 10.1.7)	4/28/14	333-195523
10.8	Form of 2013 independent director stock option agreement for options issued in exchange for the forfeiture of options granted under 2001 equity incentive plan, as amended.+		Form S-1 (Exhibit 10.1.8)	4/28/14	333-195523
10.9	Form of 2013 performance-based independent director stock option agreement granted under 2001 equity incentive plan, as amended.+		Form S-1 (Exhibit 10.1.9)	4/28/14	333-195523
10.10	2014 employee, director and consultant equity incentive plan. +		Form S-8 (Exhibit 99.10)	8/13/14	333-198124
10.11	Form of stock option agreement granted under 2014 employee, director and consultant equity incentive plan.+		Amendment No. 1 to Form S-1 (Exhibit 10.2.2)	5/14/14	333-195523
10.12	Form of restricted stock unit agreement for executive officers under 2014 employee, director and consultant equity incentive plan. +		Form 10-Q (Exhibit 10.3)	11/7/14	001-36481
10.13	Form of restricted stock agreement for directors under 2014 employee, director and consultant equity incentive plan. +		Amendment No. 1 to Form S-1 (Exhibit 10.2.3)	5/14/14	333-195523
10.14	Multi-tenant industrial net lease, dated August 20, 2001, by and between the Registrant and Cabot II — MA1M03, LLC (as successor landlord to TMT290 Industrial Park, Inc.), as amended.		Form S-1 (Exhibit 10.3)	4/28/14	333-195523

Exhibit Number	Exhibit Description	Filed with this Report	Incorporated by Reference herein from Form or Schedule	Filing Date	SEC File/Reg. Number
10.15	Amended and Restated Loan and Security Agreement dated September 3, 2014 and effective as of August 31, 2014, by and between the Company and Silicon Valley Bank.		Form 8-K (Exhibit 10.1)	9/9/14	001-36481
10.15.1	Consent and First Amendment to the Amended and Restated Loan and Security Agreement, dated August 19, 2016, by and between the Registrant and Silicon Valley Bank.		Form 10-Q (Exhibit 10.1)	11/3/16	001-36481
10.15.2	Second Amendment to the Amended and Restated Loan and Security Agreement, dated November 23, 2016, by and between the registrant and Silicon Valley Bank.		Form 10-K (Exhibit 10.15.3)	3/2/17	001-36481
10.15.3	Third Amendment to the Amended and Restated Loan and Security Agreement, dated December 27, 2016, by and between the Registrant and Silicon Valley Bank.		Form 10-K (Exhibit 10.15.4)	3/2/17	001-36481
10.15.4	Fourth Amendment to the Amended and Restated Loan and Security Agreement, dated January 27, 2017, by and between the Registrant and Silicon Valley Bank.		Form 10-Q (Exhibit 10.1)	5/5/17	001-36481
10.15.5	Fifth Amendment to the Amended and Restated Loan and Security Agreement, dated September 27, 2017, by and between the Registrant and Silicon Valley Bank.		Form 10-Q (Exhibit 10.1)	11/3/17	001-36481
10.15.6	Sixth Amendment to the Amended and Restated Loan and Security Agreement, dated January 25, 2018, by and between the Registrant and Silicon Valley Bank.		Form 10-Q (Exhibit 10.1)	5/4/18	001-36481
10.15.7	Seventh Amendment to the Amended and Restated Loan and Security Agreement, dated April 25, 2018, by and between the Registrant and Silicon Valley Bank.		Form 10-Q (Exhibit 10.1)	8/3/18	001-36481
10.15.8	Eighth Amendment to the Amended and Restated Loan and Security Agreement and First Amendment to the Preemptive Forbearance and Conditional Waiver Agreement, dated November 30, 2018, by and between the Registrant and Silicon Valley Bank, further amending a conditional waiver agreement dated August 30, 2018.		Form 10-K (Exhibit 10.15.8)	3/8/19	001-36481
10.15.9	Ninth Amendment to the Amended and Restated Loan and Security Agreement, dated March 4, 2019, by and between the Registrant and Silicon Valley Bank.		Form 10-Q (Exhibit 10.2)	5/3/19	001-36481
10.15.10	Tenth Amendment to the Amended and Restated Loan and Security Agreement, dated March 3, 2020, by and between the Registrant and Silicon Valley Bank.	X			
10.16	Executive agreement, dated as of November 7, 2018, by and between the Registrant and Donald R. Young. +		Form 10-Q (Exhibit 10.2)	11/7/18	001-36481
10.16.1	Amendment to Executive Agreement, dated as of August 1, 2019, by and between the Registrant and Donald R. Young. +		Form 10-Q (Exhibit 10.1)	8/2/19	001-36481

Exhibit Number	Exhibit Description	Filed with this Report	Incorporated by Reference herein from Form or Schedule	Filing Date	SEC File/Reg. Number
10.16.2	Second Amendment to the Executive Agreement, dated as of January 1, 2020, by and between the Registrant and Donald R. Young. +	X			
10.17	Form of executive agreement, dated as of December 21, 2018, by and between the Registrant and each of Messrs. Fairbanks and Whitaker. +		Form 8-K (Exhibit 10.1)	12/21/18	001-36481
10.18	Bonus plan. +		Amendment No. 2 to Form S-1 (Exhibit 10.15)	5/22/14	333-195523
10.19	Form of participation letter of executive officers under bonus plan. +		Form 10-K (Exhibit 10.23)	3/2/17	001-36481
10.20	Non-Employee Director Compensation Policy. +		Form 10-Q (Exhibit 10.1)	11/7/18	001-36481
10.21	Compensation Recoupment Policy.		Form 10-K (Exhibit 10.25)	3/8/19	001-36481
10.22	Cross license agreement dated as of April 1, 2006 by and between Cabot Corporation and the Registrant, as amended.*		Form S-1 (Exhibit 10.17)	4/28/14	333-195523
10.23	Form of indemnification agreement with directors and certain officers. +		Amendment No. 1 to Form S-1 (Exhibit 10.18)	5/14/14	333-195523
10.24	Inducement Agreement, dated February 15, 2016, by and between the Registrant and the Development Authority of Bulloch County, the City of Statesboro, Georgia and Bulloch County, Georgia.		Form 10-Q (Exhibit 10.1)	5/6/16	001-36481
10.25	PILOT Agreement, dated February 15, 2016, by and between the Registrant and the Development Authority of Bulloch County, the City of Statesboro, Georgia and Bulloch County, Georgia.		Form 10-Q (Exhibit 10.2)	5/6/16	001-36481
10.26	Performance and Accountability Agreement, dated February 15, 2016, by and between the Registrant and the Development Authority of Bulloch County, the Georgia Department of Community Affairs and the administering agency for the OneGeorgia Authority.		Form 10-Q (Exhibit 10.3)	5/6/16	001-36481
10.27	Supply Agreement, dated June 21, 2016, by and between the Registrant and BASF SE.*		Form 10-Q (Exhibit 10.1)	8/5/16	001-36481
10.27.1	Amended and Restated Supply Agreement, dated February 16, 2018, by and between the Registrant and BASF SE.*		Form 10-Q (Exhibit 10.2)	5/4/18	001-36481
10.27.2	First Addendum to the Amended and Restated Supply Agreement, dated January 14, 2019, by and between the Registrant and BASF SE.*		Form 10-Q (Exhibit 10.1)	5/3/19	001-36481
10.28	Side Agreement, dated June 21, 2016, by and between the Registrant and BASF SE.*		Form 10-Q (Exhibit 10.2)	8/5/16	001-36481

Exhibit Number	Exhibit Description	Filed with this Report	Incorporated by Reference herein from Form or Schedule	Filing Date	SEC File/Reg. Number
10.28.1	Amended and Restated Side Agreement, dated February 16, 2018, by and between the Registrant and BASF SE.*		Form 10-Q (Exhibit 10.3)	5/4/18	001-36481
10.29	Joint Development Agreement, dated June 21, 2016, by and between the Registrant and BASF SE.*		Form 10-Q (Exhibit 10.3)	8/5/16	001-36481
14.1	Code of business conduct and ethics.	X			
21.1	Subsidiaries of the Registrant.	X			
23.1	Consent of KPMG LLP.	X			
31.1	Certification of principal executive officer under Section 302(a) of the Sarbanes-Oxley Act of 2002.	X			
31.2	Certification of principal financial officer under Section 302(a) of the Sarbanes-Oxley Act of 2002.	X			
32	Certifications of the principal executive officer and the principal financial officer under Section 906 of the Sarbanes-Oxley Act of 2002.	X			
101	The following materials from the Registrant's Annual Report on Form 10-K for the fiscal year ended December 31, 2019, formatted in XBRL (eXtensible Business Reporting Language): (i) Consolidated Balance Sheets as of December 31, 2019 and 2018, (ii) Consolidated Statements of Operations for the Years Ended December 31, 2019, 2018 and 2017, (iii) Consolidated Statements Stockholders' Equity for the Years Ended December 31, 2019, 2018 and 2017, (iv) Consolidated Statements of Cash Flows for the Years Ended December 31, 2019, 2018, and 2017, and (v) Notes to Consolidated Financial Statements.	X			

\+ Management contract or compensatory plan or arrangement.

* Confidential treatment has been granted with respect to certain portions of this Exhibit, which portions have been omitted and filed separately with the Securities and Exchange Commission as part of an application for confidential treatment pursuant to the Securities Act of 1933, as amended.

Item 16. FORM 10-K SUMMARY

None.

SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, the registrant has duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized.

ASPEN AEROGELS, INC.

Date: March 6, 2020

By: /s/ Donald R. Young
Donald R. Young
President and Chief Executive Officer
(principal executive officer)

Pursuant to the requirements of the Securities Exchange Act of 1934, this report has been signed below by the following persons on behalf of the registrant and in the capacities indicated below and on the dates indicated.

Signature	Title	Date
/s/ Donald R. Young Donald R. Young	President, Chief Executive Officer and Director (principal executive officer)	March 6, 2020
/s/ John F. Fairbanks John F. Fairbanks	Vice President, Chief Financial Officer and Treasurer (principal financial officer and principal accounting officer)	March 6, 2020
/s/ William P. Noglows William P. Noglows	Chairman of the Board	March 6, 2020
/s/ Rebecca B. Blalock Rebecca B. Blalock	Director and Chair of the Nominating and Governance Committee	March 6, 2020
/s/ Robert M. Gervis Robert M. Gervis	Director and Chair of the Compensation and Leadership Development Committee	March 6, 2020
/s/ Steven R. Mitchell Steven R. Mitchell	Director	March 6, 2020
/s/ Mark L. Noetzel Mark L. Noetzel	Director	March 6, 2020
/s/ Richard F. Reilly Richard F. Reilly	Director and Chair of the Audit Committee	March 6, 2020

DESCRIPTION OF SECURITIES

As of December 31, 2019, Aspen Aerogels, Inc. had one class of securities registered under Section 12 of the Securities Exchange Act of 1934, as amended (the "Exchange Act"): (i) our common stock, $0.00001 par value per share ("Common Stock").

Unless the context otherwise requires, all references to "we", "us", the "Company", or "Aspen" in this Exhibit 4.3 refer to Aspen Aerogels, Inc.

DESCRIPTION OF COMMON STOCK

We are authorized to issue 125,000,000 shares of common stock, par value $0.00001 per share.

The following summary of certain provisions of our common stock does not purport to be complete. You should refer to our restated certificate of incorporation and our restated bylaws, both of which are included as exhibits to the registration statement. The summary below is also qualified by provisions of applicable law.

General

Holders of our common stock are entitled to one vote for each share held of record on all matters submitted to a vote of the stockholders, and do not have cumulative voting rights. Subject to preferences that may be applicable to any outstanding shares of preferred stock, holders of common stock are entitled to receive ratably such dividends, if any, as may be declared from time to time by our board of directors out of funds legally available for dividend payments. All shares of common stock outstanding as of the date hereof are fully paid and nonassessable. The holders of common stock have no preferences or rights of conversion, exchange, pre-emption or other subscription rights. There are no redemption or sinking fund provisions applicable to the common stock. In the event of any liquidation, dissolution or winding-up of our affairs, holders of common stock will be entitled to share ratably in our assets that are remaining after payment or provision for payment of all of our debts and obligations and after liquidation payments to holders of outstanding shares of preferred stock, if any. The rights, preferences and privileges of holders of common stock are subject to and may be adversely affected by the rights of the holders of shares of any series of then outstanding preferred stock.

Registration Rights

Pursuant to our registration rights agreement to which certain of our principal stockholders, directors and executive officers are parties, including GKFF Ventures I, LLC; Donald R. Young, our President, Chief Executive Officer and one of our directors; and John F. Fairbanks, our Vice President, Chief Financial Officer and Treasurer, are entitled to registration rights with respect to the shares of common stock held by them. These shares include substantially all of the shares held by GKFF Ventures I, LLC; and certain shares held by Donald R. Young, our President, Chief Executive Officer and one of our directors; and John F. Fairbanks, our Vice President, Chief Financial Officer and Treasurer. We are generally required to pay all expenses incurred in connection with registrations effected in connection with the following rights, excluding underwriting discounts. All registration rights described below will terminate at the earlier of (1) the seventh anniversary of the completion of our initial public offering, or June 18, 2021, (2) such shares have been registered under the Securities Act, such registration statement has been declared effective and the shares have been disposed of pursuant to such effective registration statement, and (3) with respect to any holder of registrable shares that (together with its affiliates) holds less than 1% of our common stock (on an as-if-converted to common stock basis), when such holder can sell all of such shares without limitation under Rule 144 promulgated under the Securities Act during any 90 day period.

Demand rights. Subject to specified limitations, the holders representing at least a majority of these registrable shares then outstanding may require that we register all or a portion of these securities for sale under the Securities Act, which we refer to as a demand registration, if the anticipated aggregate offering price of such securities is at least $10,000,000. We may be required to effect up to two such registrations at our expense and up to two such registrations at the holders' expense. Stockholders with these registration rights who are not part of an initial registration demand are entitled to notice and are entitled to include their shares of common stock in the registration. Under certain circumstances, the underwriters, if any, may limit the number of shares included in any such registration.

Piggyback rights. If we propose to register any of our equity securities under the Securities Act, other than in connection with (i) a registration relating solely to our employee benefit plans, or (ii) a registration relating solely to a business combination or merger involving us, the holders of these registrable shares are entitled to notice of such registration and are entitled to include their shares of common stock in the registration. Under certain circumstances, the underwriters, if any, may limit the number of shares included in any such registration.

Form S-3 rights. If we become eligible to file registration statements on Form S-3, subject to specified limitations, the holders of these registrable shares may require us to register all or a portion of their registrable shares on Form S-3, if the anticipated aggregate offering price of such securities is at least $2,000,000. Such requests for registration will not be considered a demand registration pursuant to the "— Demand rights" section above. We are not required to (i) effect more than two such registrations in any 12-month period or (ii) keep effective at any one time more than one registration statement on Form S-3 with respect to the registrable shares. Stockholders with these registration rights who are not part of an initial registration demand are entitled to notice and are entitled to include their shares of common stock in the registration. Under certain circumstances, the underwriters, if any, may limit the number of shares included in any such registration.

Transfer Agent and Registrar

The transfer agent and registrar for our common stock is Computershare Trust Company, N.A., P.O. Box 505005, Louisville, Kentucky 40233-5005.

Stock Exchange Listing

Our common stock is listed for trading on New York Stock Exchange under the symbol "ASPN."

CERTAIN PROVISIONS OF DELAWARE LAW AND OF THE COMPANY'S RESTATED CERTIFICATE OF INCORPORATION AND RESTATED BYLAWS

Anti-Takeover Provisions

The provisions of Delaware law, our restated certificate of incorporation and our restated bylaws discussed below could discourage or make it more difficult to accomplish a proxy contest or other change in our management or the acquisition of control by a holder of a substantial amount of our voting stock. It is possible that these provisions could make it more difficult to accomplish, or could deter, transactions that stockholders may otherwise consider to be in their best interests or in our best interests. These provisions are intended to enhance the likelihood of continuity and stability in the composition of our board of directors and in the policies formulated by the board of directors and to discourage certain types of transactions that may involve an actual or threatened change of our control. These provisions are designed to reduce our vulnerability to an unsolicited acquisition proposal and to discourage certain tactics that may be used in proxy fights. Such provisions also may have the effect of preventing changes in our management.

Delaware Statutory Business Combinations Provision

We are subject to Section 203 of the Delaware General Corporation Law. This statute regulating corporate takeovers prohibits a Delaware corporation from engaging in any business combination with any interested stockholder for three years following the date that the stockholder became an interested stockholder, unless:

- prior to the date of the transaction, the board of directors of the corporation approved either the business combination or the transaction which resulted in the stockholder becoming an interested stockholder;

- upon completion of the transaction that resulted in the interested stockholder becoming an interested stockholder, the interested stockholder owned at least 85% of the voting stock of the corporation outstanding at the time the transaction commenced, excluding for purposes of determining the number of shares outstanding (a) shares owned by persons who are directors and also officers, and (b) shares owned by employee stock plans in which employee participants do not have the right to determine confidentially whether shares held subject to the plan will be tendered in a tender or exchange offer; or

- on or subsequent to the date of the transaction, the business combination is approved by the board of directors and authorized at an annual or special meeting of stockholders, and not by written consent, by the affirmative vote of at least 66 2/3% of the outstanding voting stock which is not owned by the interested stockholder.

Generally, a business combination includes a merger, asset or stock sale, or other transaction resulting in a financial benefit to the interested stockholder. An interested stockholder is any person who, together with such person's affiliates and associates (i) owns 15% or more of a corporation's voting securities or (ii) is an affiliate or associate of a corporation and was the owner of 15% or more of the corporation's voting securities at any time within the three year period immediately preceding a business combination of the corporation governed by Section 203. We expect the existence of this provision to have an anti-takeover effect with respect to transactions our board of directors does not approve in advance. We also anticipate that Section 203 may discourage takeover attempts that might result in a premium over the market price for the shares of Common Stock held by our stockholders.

Classified Board of Directors; Removal of Directors for Cause

Our restated certificate of incorporation and restated bylaws provide that our board of directors will be divided into three classes, with the term of office of the first class to expire at the first annual meeting of stockholders following the initial classification of directors, the term of office of the second class to expire at the second annual meeting of stockholders following the initial classification of directors and the term of office of the third class to expire at the third annual meeting of stockholders following the initial classification of directors. At each annual meeting of stockholders, directors elected to succeed those directors whose terms expire will be elected for a three-year term of office. All directors elected to our classified board of directors will serve until the election and qualification of their respective successors or their earlier resignation or removal. The board of directors is authorized to create new directorships and to fill such positions so created and is permitted to specify the class to which any such new position is assigned. The person filling such position would serve for the term applicable to that class. The board of directors, or its remaining members, even if less than a quorum, is also empowered to fill vacancies on the board of directors occurring for any reason for the remainder of the term of the class of directors in which the vacancy occurred. Members of the board of directors may only be removed for cause and only by the affirmative vote of 75% of our outstanding voting stock. These provisions are likely to increase the time required for stockholders to change the composition of the board of directors. For example, at least two annual meetings will be necessary for stockholders to effect a change in a majority of the members of the board of directors.

Advance Notice Provisions for Stockholder Proposals and Stockholder Nominations of Directors

Our restated bylaws provide that, for nominations to the board of directors or for other business to be properly brought by a stockholder before a meeting of stockholders, the stockholder must first have given timely notice of the proposal in writing to our Secretary. For an annual meeting, a stockholder's notice generally must be delivered not less than 90 days nor more than 120 days prior to the anniversary of the previous year's annual meeting. For a special meeting, the notice must generally be delivered not earlier than the 90th day prior to the meeting and not later than the later of (1) the 60th day prior to the meeting or (2) the 10th day following the day on which public announcement of the meeting is first made. Detailed requirements as to the form of the notice and information required in the notice are specified in the restated bylaws. If it is determined that business was not properly brought before a meeting in accordance with our bylaw provisions, such business will not be conducted at the meeting.

Special Meetings of Stockholders

Special meetings of the stockholders may be called only by our board of directors pursuant to a resolution adopted by a majority of the total number of directors.

No Stockholder Action by Written Consent

Our restated certificate of incorporation and restated bylaws do not permit our stockholders to act by written consent. As a result, any action to be effected by our stockholders must be effected at a duly called annual or special meeting of the stockholders.

Super Majority Stockholder Vote Required for Certain Actions

The Delaware General Corporation Law provides generally that the affirmative vote of a majority of the shares entitled to vote on any matter is required to amend a corporation's certificate of incorporation or bylaws, unless the corporation's certificate of incorporation or bylaws, as the case may be, requires a greater percentage. Our restated certificate of incorporation requires the affirmative vote of the holders of at least 75% of our outstanding voting stock to amend or repeal any of the provisions discussed in this section entitled "—Anti-Takeover Provisions" or to reduce the number of authorized shares of common stock or preferred stock. This 75% stockholder vote would be in addition to any separate class vote that might in the future be required pursuant to the terms of any preferred stock that might then be outstanding. In addition, a 75% vote is also required for any amendment to, or repeal of, our restated bylaws by the stockholders. Our restated bylaws may be amended or repealed by a simple majority vote of the board of directors.

Exclusive Forum

Our restated certificate of incorporation provides that, subject to limited exceptions, a state or federal court located within the State of Delaware will be the sole and exclusive forum for (1) any derivative action or proceeding brought on our behalf, (2) any action asserting a claim of breach of a fiduciary duty owed by any of our directors, officers or other employees to us or our stockholders, (3) any action asserting a claim against us arising pursuant to any provision of the Delaware General Corporation Law, our certificate of incorporation or our bylaws, or (4) any other action asserting a claim against us that is governed by the internal affairs doctrine. Any person or entity purchasing or otherwise acquiring any interest in shares of our capital stock shall be deemed to have notice of and to have consented to the provisions of our restated certificate of incorporation described above. Although we believe these provisions benefit us by providing increased consistency in the application of Delaware law for the specified types of actions and proceedings, the provisions may have the effect of discouraging lawsuits against our directors and officers. The enforceability of similar choice of forum provisions in other companies' certificates of incorporation has been challenged in legal proceedings, and it is possible that, in connection with one or more actions or proceedings described above, a court could find the choice of forum provisions contained in our restated certificate of incorporation to be inapplicable or unenforceable.

TENTH AMENDMENT
TO
AMENDED AND RESTATED LOAN AND SECURITY AGREEMENT

This Tenth Amendment to Amended and Restated Loan and Security Agreement (this "**Amendment**") is entered into this 3rd day of March, 2020 by and between **SILICON VALLEY BANK** ("**Bank**") and **ASPEN AEROGELS, INC.**, a Delaware corporation ("**Borrower**") whose address is 30 Forbes Road, Building B, Northborough, Massachusetts 01532.

Recitals

A. Bank and Borrower have entered into that certain Amended and Restated Loan and Security Agreement dated as of September 3, 2014, as amended by that certain Consent and First Amendment to Amended and Restated Loan and Security Agreement dated as of August 19, 2016, as further amended by that certain Second Amendment to Amended and Restated Loan and Security Agreement dated as of November 23, 2016, as further amended by that certain Third Amendment to Amended and Restated Loan and Security Agreement dated as of December 29, 2016, as further amended by that certain Fourth Amendment to Amended and Restated Loan and Security Agreement dated as of January 27, 2017, as further amended by that certain Fifth Amendment to Amended and Restated Loan and Security Agreement dated as of September 27, 2017, as further amended by that certain Consent and Sixth Amendment to Amended and Restated Loan and Security Agreement dated as of January 25, 2018, as further amended by that certain Seventh Amendment to Amended and Restated Loan and Security Agreement dated as of April 25, 2018, as further amended by that certain Eighth Amendment to Amended and Restated Loan and Security Agreement and First Amendment to Preemptive Forbearance and Conditional Waiver Agreement dated as of November 30, 2018, and as further amended by that certain Ninth Amendment to Amended and Restated Loan and Security Agreement dated as of March 4, 2019 (as amended, and as the same may from time to time be further amended, restated, amended and restated, modified and/or supplemented, the "**Loan Agreement**").

B. Bank has extended credit to Borrower for the purposes permitted in the Loan Agreement.

C. Borrower has requested that Bank amend the Loan Agreement to make certain revisions to the Loan Agreement as more fully set forth herein.

D. Bank has agreed to so amend certain provisions of the Loan Agreement, but only to the extent, in accordance with the terms, subject to the conditions and in reliance upon the representations and warranties set forth below.

Agreement

Now, Therefore, in consideration of the foregoing recitals and other good and valuable consideration, the receipt and adequacy of which is hereby acknowledged, and intending to be legally bound, the parties hereto agree as follows:

1. **Definitions.** Capitalized terms used but not defined in this Amendment shall have the meanings given to them in the Loan Agreement.

2. **Amendments to Loan Agreement.**

2.1 **Section 6.8 (Operating Accounts)**. Section 6.8 is amended in its entirety and replaced with the following:

"**6.8 Operating Accounts**.

(a) Borrower, any Subsidiary of Borrower and any Guarantor shall maintain all of its operating accounts and excess cash with Bank or Bank's Affiliates, except with respect to accounts of Aspen Aerogels Germany GmbH with a balance of less than $50,000 in the aggregate.

(b) Provide Bank five (5) days prior written notice before establishing any Collateral Account at or with any bank or financial institution other than Bank or Bank's Affiliates. For each Collateral Account that Borrower at any time maintains, Borrower shall cause the applicable bank or financial institution (other than Bank) at or with which any Collateral Account is maintained to execute and deliver a Control Agreement or other appropriate instrument customary to such other banks or financial institutions with respect to such Collateral Account to perfect Bank's Lien in such Collateral Account in accordance with the terms hereunder which Control Agreement may not be terminated without the prior written consent of Bank, provided that Control Agreements shall not be required for Collateral Accounts with a balance of less than $50,000 individually or $250,000 in the aggregate.

(c) Borrower, any Subsidiary of Borrower and any Guarantor shall obtain any business credit card exclusively from Bank."

2.2 **Section 6.9 (Financial Covenants)**. Section 6.9 is amended in its entirety and replaced with the following:

"**6.9 Financial Covenant**. Borrower shall achieve, measured as of the end of each fiscal quarter during the following periods, EBITDA of at least (loss not worse than) the following for the following periods:

Period	**Minimum EBITDA (maximum loss)**
Trailing three (3) month period ending March 31, 2020	($4,500,000)
Trailing six (6) month period ending June 30, 2020	($6,500,000)
Trailing nine (9) month period ending September 30, 2020	($3,000,000)
Trailing twelve (12) month period ending December 31, 2020	$1,000,000"

2.3 **Section 6.12** (**Formation or Acquisition of Subsidiaries**). Section 6.12 is deleted in its entirety and replaced with the following:

"**6.12 Formation or Acquisition of Subsidiaries**. Notwithstanding and without limiting the negative covenants contained in Sections 7.3 and 7.7 hereof, in the event Borrower or any Guarantor creates or acquires any Subsidiary (including, without limitation, pursuant to a Division), Borrower and such Guarantor shall, prior to the creation or acquisition of such new Subsidiary, promptly notify the Bank thereof and, at Bank's request, in its sole discretion, take all such action as may be reasonably required by Bank to (a) cause each such Subsidiary to, in Bank's sole discretion, become a co-borrower or Guarantor hereunder, together with such appropriate financing statements and/or Control Agreements, all in form and substance satisfactory to Bank (including being sufficient to grant Bank a first priority Lien (subject to Permitted Liens) in and to the assets of such newly formed or acquired Subsidiary), (b) provide to Bank appropriate certificates and powers and financing statements, pledging all of the direct or beneficial ownership interest in such new Subsidiary, in form and substance satisfactory to Bank; provided, that with respect to any Foreign Subsidiary, Borrower shall only be required to grant and pledge to Bank a perfected security interest in up to sixty-five percent (65%) of the stock, units or other evidence of ownership of such Foreign Subsidiary; and (c) provide to Bank all other documentation in form and substance satisfactory to Bank, including one or more opinions of counsel satisfactory to Bank, which in its opinion is appropriate with respect to the execution and delivery of the applicable documentation referred to above. Any document, agreement, or instrument executed or issued pursuant to this Section 6.12 shall be a Loan Document."

2.4 **Section 7.1** (**Dispositions**). Section 7.1 is deleted in its entirety and replaced with the following:

"**7.1** **Dispositions**. Convey, sell, lease, transfer, assign, or otherwise dispose of (including, without limitation, pursuant to a Division) (collectively, "**Transfer**"), or permit any of its Subsidiaries to Transfer, all or any part of its business or property, except for Transfers (a) of Inventory in the ordinary course of business; (b) of worn out or obsolete Equipment; (c) consisting of Permitted Liens and Permitted Investments; and (d) of non-exclusive licenses for the use of the property of Borrower or its Subsidiaries in the ordinary course of business."

2.5 **Section 7.3** (**Mergers or Acquisitions**). Section 7.3 is deleted in its entirety and replaced with the following:

"**7.3** **Mergers or Acquisitions**. Merge or consolidate, or permit any of its Subsidiaries to merge or consolidate, with any other Person, or acquire, or permit any of its Subsidiaries to acquire, all or substantially all of the capital stock or property of another Person (including, without limitation, by the formation of any Subsidiary or pursuant to a Division). A Subsidiary may merge or consolidate into another Subsidiary or into Borrower."

2.6 **Section 13** (**Definitions**). The following term and its definition set forth in Section 13.1 is amended in its entirety and replaced with the following:

" "**Revolving Line Maturity Date**" is April 28, 2021.

2.7 **Section 13** (**Definitions**). The following new defined terms are hereby inserted alphabetically in Section 13.1:

" "**Division**" means, in reference to any Person which is an entity, the division of such Person into two (2) or more separate Persons, with the dividing Person either continuing or terminating its existence as part of such division, including, without limitation, as contemplated under Section 18-217 of the Delaware Limited Liability Company Act for limited liability companies formed under Delaware law, or any analogous action taken pursuant to any other applicable law with respect to any corporation, limited liability company, partnership or other entity."

2.8 **Exhibit B (Compliance Certificate)**. The Compliance Certificate attached to the Loan Agreement as Exhibit B is amended in its entirety and replaced with the Compliance Certificate in the form of Exhibit B attached hereto.

3. **Limitation of Amendments.**

3.1 The amendments set forth in Section 2 above are effective for the purposes set forth herein and shall be limited precisely as written and shall not be deemed to (a) be a consent to any amendment, waiver or modification of any other term or condition of any Loan Document, or (b) otherwise prejudice any right or remedy which Bank may now have or may have in the future under or in connection with any Loan Document.

3.2 This Amendment shall be construed in connection with and as part of the Loan Documents and all terms, conditions, representations, warranties, covenants and agreements set forth in the Loan Documents, except as herein amended, are hereby ratified and confirmed and shall remain in full force and effect.

4. **Representations and Warranties.** To induce Bank to enter into this Amendment, Borrower hereby represents and warrants to Bank as follows:

4.1 Immediately after giving effect to this Amendment (a) the representations and warranties contained in the Loan Documents are true, accurate and complete in all material respects as of the date hereof (except to the extent such representations and warranties relate to an earlier date, in which case they are true and correct as of such date), and (b) no Event of Default has occurred and is continuing;

4.2 Borrower has the power and authority to execute and deliver this Amendment and to perform its obligations under the Loan Agreement, as amended by this Amendment;

4.3 The organizational documents of Borrower delivered to Bank on the Effective Date remain true, accurate and complete and have not been amended, supplemented or restated and are and continue to be in full force and effect;

4.4 The execution and delivery by Borrower of this Amendment and the performance by Borrower of its obligations under the Loan Agreement, as amended by this Amendment, have been duly authorized;

4.5 The execution and delivery by Borrower of this Amendment and the performance by Borrower of its obligations under the Loan Agreement, as amended by this Amendment, do not and will not contravene (a) any law or regulation binding on or affecting Borrower, (b) any contractual restriction with a Person binding on Borrower, (c) any order, judgment or decree of any court or other governmental or public body or authority, or subdivision thereof, binding on Borrower, or (d) the organizational documents of Borrower;

4.6 The execution and delivery by Borrower of this Amendment and the performance by Borrower of its obligations under the Loan Agreement, as amended by this Amendment, do not require any order, consent, approval, license, authorization or validation of, or filing, recording or registration with, or exemption by any governmental or public body or authority, or subdivision thereof, binding on Borrower, except as already has been obtained or made; and

4.7 This Amendment has been duly executed and delivered by Borrower and is the binding obligation of Borrower, enforceable against Borrower in accordance with its terms, except as such enforceability may be limited by bankruptcy, insolvency, reorganization, liquidation, moratorium or other similar laws of general application and equitable principles relating to or affecting creditors' rights.

5. **Updated Perfection Certificate**. Borrower has delivered an updated Perfection Certificate dated **March 2, 2020** ("2020 Updated Perfection Certificate"), which 2020 Updated Perfection Certificate will supersede in all respects previous perfection certificates including the one dated March 1, 2019. Borrower and Bank acknowledge and agree that all references in the Loan Agreement to the "Perfection Certificate" shall hereafter be a reference to 2020 Updated Perfection Certificate herein.

6. **No Defenses of Borrower.** Borrower hereby acknowledges and agrees that Borrower has no offsets, defenses, claims, or counterclaims against Bank with respect to the Obligations, or otherwise, and that if Borrower now has, or ever did have, any offsets, defenses, claims, or counterclaims against Bank, whether known or unknown, at law or in equity, all of them are hereby expressly WAIVED and Borrower hereby RELEASES Bank from any liability thereunder.

7. **Integration**. This Amendment and the Loan Documents represent the entire agreement about this subject matter and supersede prior negotiations or agreements. All prior agreements, understandings, representations, warranties, and negotiations between the parties about the subject matter of this Amendment and the Loan Documents merge into this Amendment and the Loan Documents.

8. **Counterparts.** This Amendment may be executed in any number of counterparts and all of such counterparts taken together shall be deemed to constitute one and the same instrument.

9. **Fees and Expenses**. Borrower agrees to promptly pay Bank, upon receipt of an invoice, Bank's legal fees and expenses incurred in connection with this Amendment.

10. **Effectiveness**. As a condition precedent to the effectiveness of this Amendment and the Bank's obligation to make further Advances under the Revolving Line, the Bank shall have received the following documents prior to or concurrently with this Amendment, each in form and substance reasonably satisfactory to Bank:

10.1 this Amendment and the 2020 Updated Perfection Certificate duly executed on behalf of Borrower;

10.2 the Acknowledgment of Amendment and Reaffirmation of Guaranty substantially in the form attached hereto as **Schedule 1**, duly executed and delivered by Guarantor;

10.3 a good standing certificate of Borrower and Guarantor, certified by the jurisdiction of incorporation of Borrower, dated as of a date no earlier than thirty (30) days prior to the date hereof;

10.4 certified copies, dated as of a recent date, of financing statement and other lien searches of Borrower and Guarantor, as Bank may request and which shall be obtained by Bank, accompanied by written evidence (including any Uniform Commercial Code termination statements) that the Liens revealed in any such searched either (i) will be terminated prior to or in connection with this Amendment, or (ii) in the sole discretion of Bank, will constitute Permitted Liens;

10.5 Borrower's payment of a fully earned, non-refundable amendment fee in the amount of Fifty Thousand Dollars ($50,000), payable in full on the date hereof;

10.6 evidence satisfactory to Bank that the insurance policies required by Section 6.7 of the Loan Agreement are in full force and effect; and

10.7 such other documents as Bank may reasonably request.

11. **Post-Closing Requirements.** Within thirty (30) days after the date of this Amendment, Borrower shall deliver to Bank (i) evidence satisfactory to Bank that the insurance endorsements required by Section 6.7 of the Loan Agreement are in full force and effect and (ii) a duly executed bailee's waiver in favor of Bank in form and substance reasonably satisfactory to Bank pertaining to 743 North Main Street, Woonsocket, Rhode Island. Failure to comply with the foregoing requirements within the time period noted, or such longer period as Bank may agree in its sole discretion, shall constitute an Event of Default for which no grace or cure period shall apply.

[Signature page follows.]

In Witness Whereof, the parties hereto have caused this Amendment to be duly executed and delivered as of the date first written above.

BANK	**BORROWER**
SILICON VALLEY BANK	ASPEN AEROGELS, INC.
By: /s/ Steve Lyons	By: /s/ John F. Fairbanks
Name: Steve Lyons	Name: John F. Fairbanks
Title: Director	Title: Chief Financial Officer

Schedule 1

**ACKNOWLEDGMENT OF AMENDMENT
AND REAFFIRMATION OF GUARANTY**

Section 1. Guarantor hereby acknowledges and confirms that it has reviewed and approved the terms and conditions of the Tenth Amendment to Amended and Restated Loan and Security Agreement dated as of the date hereof ("the "**Amendment**").

Section 2. Guarantor hereby consents to the Amendment and agrees that the Guaranty relating to the Obligations of Borrower under the Loan Agreement shall continue in full force and effect, shall be valid and enforceable and shall not be impaired or otherwise affected by the execution of the Amendment or any other document or instruction delivered in connection herewith.

Section 3. Guarantor represents and warrants that, after giving effect to the Amendment, all representations and warranties contained in the Guaranty are true, accurate and complete as if made the date hereof.

Dated as of March 3, 2020.

GUARANTOR: ASPEN AEROGELS RHODE ISLAND, LLC

By: /s/ John F. Fairbanks

Name: John F. Fairbanks

Title: Chief Financial Officer

EXHIBIT B

COMPLIANCE CERTIFICATE

TO: SILICON VALLEY BANKDate: -
FROM: ASPEN AEROGELS, INC.

The undersigned authorized officer of Aspen Aerogels, Inc. ("**Borrower**") certifies that under the terms and conditions of the Amended and Restated Loan and Security Agreement between Borrower and Bank (as amended and in effect, the "**Agreement**"), (1) Borrower is in complete compliance for the period ending _______________ with all required covenants except as noted below, (2) there are no Events of Default, (3) all representations and warranties in the Agreement are true and correct in all material respects on this date except as noted below; provided, however, that such materiality qualifier shall not be applicable to any representations and warranties that already are qualified or modified by materiality in the text thereof; and provided, further that those representations and warranties expressly referring to a specific date shall be true, accurate and complete in all material respects as of such date, (4) Borrower, and each of its Subsidiaries, has timely filed all required tax returns and reports, and Borrower has timely paid all foreign, federal, state and local taxes, assessments, deposits and contributions owed by Borrower except as otherwise permitted pursuant to the terms of Section 5.9 of the Agreement, and (5) no Liens have been levied or claims made against Borrower or any of its Subsidiaries, if any, relating to unpaid employee payroll or benefits of which Borrower has not previously provided written notification to Bank. Attached are the required documents supporting the certification. The undersigned certifies that these are prepared in accordance with GAAP consistently applied from one period to the next except as explained in an accompanying letter or footnotes. The undersigned acknowledges that no borrowings may be requested at any time or date of determination that Borrower is not in compliance with any of the terms of the Agreement, and that compliance is determined not just at the date this certificate is delivered. Capitalized terms used but not otherwise defined herein shall have the meanings given them in the Agreement.

ndicate compliance status by circling Yes/No under "Complies" column.

Reporting Covenant	Required	Complies
ıly financial statements with liance Certificate	Monthly within 30 days	Yes No
ːrly financial statements	Quarterly within 45 days	Yes No
ıl financial statement (CPA Audited) + CC	FYE within 150 days	Yes No
10-K and 8-K	Within 5 days after filing with SEC	Yes No
: A/P Agings, and Deferred Revenue reports	Monthly within 20 days	Yes No
ving Base Reports	15th and last Business Day of each month (monthly within 20 days when a Streamline Period is in effect) and with each request for a Credit Extension;	Yes No
tions	FYE within 30 days	Yes No
ıllowing Intellectual Property was registered after the Effective Date (if no registrations, state ")____		

Financial Covenant	Required	Actual	Complies
ain as indicated:			
ıum EBITDA	*	$	Yes No

*See Section 6.9

Performance Pricing		Applies
ted Quick Ratio at least 1.50:1.00	Prime + 0.75% (Eligible Accounts) or Prime + 1.25% (Eligible Foreign Accounts); LIBOR + 3.75% (Eligible Accounts) or LIBOR +4.25% (Eligible Foreign Accounts)	Yes No
ted Quick Ratio less than 1.50:1.00	Prime + 1.50% (Eligible Accounts); Prime + 2.00% (Eligible Foreign Accounts)	Yes No

The following financial covenant analyses and information set forth in Schedule 1 attached hereto are true and accurate as of the date of this Certificate.

The following are the exceptions with respect to the certification above: (If no exceptions exist, state "No exceptions to note.")

ASPEN AEROGELS, INC.

By:

Name:

Title:

BANK USE ONLY

Received By:
AUTHORIZED SIGNER

Date:

Verified:
AUTHORIZED SIGNER

Date:

Compliance Status: Yes No

Schedule 1 to Compliance Certificate

Financial Covenants of Borrower

In the event of a conflict between this Schedule and the Loan Agreement, the terms of the Loan Agreement shall govern.

I. **EBITDA** (Section 6.9)

Required: Borrower shall achieve, measured as of the end of each fiscal quarter during the following periods, EBITDA of at least (loss not worse than) the following for the following periods:

Period	Minimum EBITDA (maximum loss)
Trailing three (3) month period ending March 31, 2020	($4,500,000)
Trailing six (6) month period ending June 30, 2020	($6,500,000)
Trailing nine (9) month period ending September 30, 2020	($3,000,000)
Trailing twelve (12) month period ending December 31, 2020	$1,000,000

Actual:

A. Net Income

B. To the extent included in the determination of Net Income

1.The provision for income taxes

2.Depreciation expense

3.Amortization expense

4.Net Interest Expense

5.Non-cash stock compensation expense

6.The sum of lines 1 through 5

C. EBITDA (line A plus line B.6)

Is line C equal to or greater than $___________?

No, not in compliance

Yes, in compliance

Exhibit 10.16.2

SECOND AMENDMENT TO EXECUTIVE AGREEMENT

This Amendment (“Amendment”), dated as of January 1, 2020, is entered into by and between Aspen Aerogels, Inc., a Delaware corporation (the “Company”), and Donald R. Young (the “Executive”), for purposes of amending that certain Executive Agreement between the parties effective as of January 1, 2019 as previously amended on August 1, 2019 (the “Executive Agreement”).

RECITALS

Whereas, the Company and the Executive wish to amend the Executive Agreement to provide for the accelerated vesting of stock options and stock-based awards in connection with a Qualifying Termination (as defined in the Executive Agreement) and to extend the time allowed to exercise all vested stock options in the event of a Qualifying Termination ; and

Now, therefore, in consideration of mutual promises and other terms set forth below, the Company and the Executive agree as follows:

1. Amendment. The Executive Agreement is hereby amended as follows:

(I) A new sub-paragraph is added to Section 4(b) and numbered Section 4(b)(vi) so that it applies only in connection with a Qualifying Termination prior to Change of Control. The new Section 4(b)(vi) provides as follows:.

Options and Stock Based Awards. Notwithstanding anything to the contrary in any then outstanding option agreement or stock-based award agreement (other than the Restricted Stock Agreement, which will continued to be governed in accordance with its terms), (a) the vesting of such number of stock options and other stock-based awards outstanding and held by the Executive as would have vested in the three (3) months immediately following the Date of Termination had the Executive continued his employment for such three (3) month period shall immediately accelerate and become vested and exercisable as of the Date of Termination and (b) subject to any permitted action by the Board upon a Change of Control or other merger, sale, dissolution or liquidation of the Company under Company’s applicable equity plan to terminate the stock options or other stock-based awards, all vested stock options shall be exercisable for not less than one (1) year from the Date of Termination.

(II) The text of Section 4(c) is deleted in full and shall now provide that it is “RESERVED”

(III) A new sub-paragraph is added to Section 5(a) and numbered Section 5(a)(xi) so that it applies only in connection with a Qualifying Termination after a Change of Control. The new Section 5(a)(xi) provides as follows:

Options and Stock Based Awards. Notwithstanding anything to the contrary in any then outstanding option agreement or stock-based award agreement (other than the Restricted Stock Agreement, which will continued to be governed in accordance with its terms), the vesting of all stock options and other stock-based awards outstanding and held by the Executive shall immediately accelerate and become fully vested and exercisable as of the Date of Termination, and subject to any permitted action by the Board upon a Change of Control under Company’s applicable equity plan to terminate the stock options or other stock-based awards, all vested stock options shall be exercisable for one (1) year from the Date of Termination.

(IV) The text of Section 5(b) is deleted in full and shall now provide that it is “RESERVED”

2. Miscellaneous Provisions. Capitalized terms used but not defined within this Amendment have the meanings specified within the Executive Agreement. Except as expressly modified by this Amendment, all terms and conditions of the Executive Agreement remain in full force and effect. This Amendment can be executed by the parties hereto by facsimile and in counterparts, each of which is deemed an original and both of which taken together constitutes one agreement binding upon the parties hereto. This Amendment shall be governed by and construed in accordance with the laws of the Commonwealth of Massachusetts, without giving effect to any choice of law or conflict of law provision or rule (whether of the Commonwealth of Massachusetts or any other jurisdiction) that would cause the application of the law of any jurisdiction other than the Commonwealth of Massachusetts.

In witness whereof, the Parties hereto enter into this Amendment by signing below.

ASPEN AEROGELS, INC.

By: /s/ John F. Fairbanks

John F. Fairbanks
Name

Vice President, Chief Financial Officer and Treasurer
Title

January 31, 2020
Date

/s/ Donald R. Young
Donald R. Young

January 31, 2020
Date

Exhibit 14.1

ASPEN AEROGELS, INC.

CODE OF BUSINESS CONDUCT AND ETHICS[1]

INTRODUCTION

This Code of Business Conduct and Ethics, referred to as the "**Code**," is intended to provide associates of Aspen Aerogels Inc. ("Company"), as defined below, with a clear understanding of the principles of business conduct and ethics that are expected of them and to aid them in making ethical and legal decisions when conducting the Company's business and performing day-to-day duties. The standards set forth in the Code apply to us all, including at the Company and all of its subsidiaries and other business entities controlled by the Company everywhere in the world. Every associate of the Company must acknowledge his or her review of and agreement to comply with the Code as a condition of his or her relationship with the company (see Appendix A attached hereto). The term "**associate**" means (i) every full and part-time employee of the Company and its subsidiaries, (ii) all members of the Company's senior management, including the Company's Chief Executive Officer and Chief Financial Officer, and (iii) every member of the Company's Board of Directors, even if such member is not employed by the Company. This Code has been approved by the Board of Directors of the Company and may not be modified, amended or restated without the approval of the Board of Directors.

REPORTING VIOLATIONS UNDER THE CODE

- *If any breach of the Code is known to you, you are obligated to report violations via one or more of the following four alternatives specified in the Company's Whistleblower Policy: (i) by reporting up the supervisory chain, beginning with your immediate supervisor or with a more senior supervisor; (ii) by contacting any member of the Compliance Committee, including the Corporate Compliance Officer; (iii) by contacting the chairperson of the Company's Audit Committee; or (iv) by anonymously and confidentially reporting violations to the third party service provider retained by the Company, AlertLine (the "**Whistleblower Hotline**").*

The Whistleblower Hotline may be reached 24 hours a day, 7 days a week at the following toll-free number and internet address:

ALERTLINE TELEPHONE NUMBER: 1-877-376-2006 (Toll Free)

ALERTLINE INTERNET ADDRESS: http://www.aerogel.com/company/alertline/

*See the Company's Whistleblower Policy, which can be accessed on the Company's Intranet. These alternative methods for reporting a violation are referred to throughout the Code as the "**Reporting Mechanism.**"*

Any associate of the Company having any information or knowledge regarding the existence of any violation or suspected violation of the Code (including, but not limited to, suspected violations of securities or antifraud laws, accounting issues, and any law relating to fraud against shareholders) has a duty to report the violation or suspected violation using the Reporting Mechanism described above. As specified in the Whistleblower Policy, associates may also report using the Reporting Mechanism any concerns an associate may have with respect to the Company including, but not limited to, concerns with the Company's business or operations or any other issue concerning the Company and their employment with the Company. Reports made to the Whistleblower Hotline will

---

* This Code of Business Conduct and Ethics which reflects certain non-substantive and administrative changes to the prior code, replaces and supersedes the Company's prior code on business conduct and ethics and became effective on February 26, 2020.

be provided directly to the Audit Committee on an anonymous and confidential basis.

Failure to report suspected or actual violations is itself a violation of the Code and may subject the associate to disciplinary action, up to and including termination of employment or legal action. Reports may be made on a confidential and anonymous basis. To the extent any investigation is necessitated by a report, the Company will endeavor to keep the proceedings and the identity of the reporting associate confidential to the fullest extent permitted by applicable law.

ANTI-RETALIATION PLEDGE

Any associate who in good faith reports a suspected violation under the Code by the Company, or its agents acting on behalf of the Company, or who in good faith raises issues or concerns regarding the Company's business or operations, using the Reporting Mechanism, may not be fired, suspended, demoted, reprimanded, threatened, harassed or in any manner discriminated against in the terms and conditions of the associate's employment for, or because of, the reporting of the suspected violation, issues or concerns, regardless of whether the suspected violation involves the associate, the associate's supervisor or senior management of the Company.

In addition, any associate who in good faith reports a suspected violation under the Code which the associate reasonably believes constitutes a violation of a federal, state, local or foreign statute by the Company, or its agents acting on behalf of the Company, to a federal, state, local or foreign regulatory or law enforcement agency, may not be fired, suspended, demoted, reprimanded, threatened, harassed or in any manner discriminated against in the terms and conditions of the associate's employment for, or because of, the reporting of the suspected violation, regardless of whether the suspected violation involves the associate, the associate's supervisor or senior management of the Company.

COMPLYING WITH THE CODE

The ultimate responsibility for maintaining our Code rests with each of us. As individuals of personal integrity, we can do no less than to behave in a way that will continue to bring credit to ourselves and our Company. Applying these standards to our business lives is an extension of the values by which we are known as individuals and by which we want to be known as a Company. To that end, the Company has made the Code publicly available on its website. It is our responsibility to conduct ourselves in an ethical business manner and also to ensure that others do the same. If any one of us violates these standards, he or she can expect disciplinary action, up to and including termination of any employment or other relationship with the Company, and possibly other legal action.

While it is impossible for this Code to describe every situation that may arise, the standards explained in this Code are guidelines that should govern our conduct at all times. If you are confronted with situations not covered by this Code, or have questions regarding the matters that are addressed in the Code, you are urged to consult with the Corporate Compliance Officer, a member of the Compliance Committee, or another member of management. Furthermore, the policies set forth in this Code are in addition to other policies of the Company that associates must comply with, including those set forth in the Company's Employee Handbook. Copies of these other policies are available via the Company's Intranet.

The provisions of the Code regarding the actions the Company will take are guidelines which the Company intends to follow. There may be circumstances, however, that in the Company's judgment require different measures or actions and in such cases it may act accordingly while still attempting to fulfill the principles underlying this Code. In the case of any inconsistency between the provisions set out in this Code and the rules contained in any mandatory text, laws or interpretive case law applicable to the Company and its associates, the latter will prevail. In no instance should this Code be interpreted as modifying, amending or otherwise changing any legal text and related legal precedents that apply to the Company and its associates.

Table of Contents

Page

I. IMPLEMENTATION OF THE CODE

The following questions and answers address the Company's implementation of the Code. The Company has attempted to design procedures that ensure maximum confidentiality, anonymity, and, most importantly, freedom from the fear of retaliation for complying with and reporting violations under the Code.

Q: Who is responsible for administering, updating and enforcing the Code?

A: The Company's Board of Directors has appointed a Corporate Compliance Officer and a Compliance Committee that includes the Corporate Compliance Officer and at least 1 additional member to administer, update and enforce the Code. Ultimately, the Board of Directors of the Company must ensure that the Corporate Compliance Officer and the Compliance Committee fulfill their responsibilities.

The Corporate Compliance Officer has overall responsibility for overseeing the implementation of the Code. Specific responsibilities of the position are to:

- Develop the Code based on legal requirements, regulations and ethical considerations that are raised in the Company's operations;
- Ensure that the Code is distributed to all associates and that all associates acknowledge the principles of the Code;
- Work with the Company's Audit Committee to provide a Reporting Mechanism so that associates have a confidential and anonymous method of reporting not only suspected violations of the Code but concerns regarding federal securities or antifraud laws, accounting issues, or any federal law relating to fraud against shareholders;
- Implement a training program to ensure that associates are aware of and understand the Code;
- Audit and assess compliance success with the Code;
- Serve as a point person for reporting violations and asking questions under the Code;
- Maintain a log of all reports under the Reporting Mechanism and provide this log to the Audit Committee for their review at regular intervals; and
- Revise and update the Code as necessary to respond to detected violations and changes in the law.

The Compliance Committee is appointed by the Audit Committee of the Board and is comprised of a Corporate Compliance Officer, and at least another member. At least one member is selected from the Human Resources Department. The current composition of the Compliance Committee is provided in Appendix E.

The primary responsibilities of the Compliance Committee are to:

- Assist the Corporate Compliance Officer in developing and updating the Code;
- Develop internal procedures to monitor and audit compliance with the Code;
- Serve as point persons for reporting violations and asking questions under the Code;
- Set up a mechanism for anonymous reporting of suspected violations of the Code by associates and refer, when appropriate, such reports to the Audit Committee;
- Maintain a log of all reports under the Reporting Mechanism and provide this log to the Audit Committee for their review at regular intervals;
- Conduct internal investigations, with the assistance of counsel, of suspected compliance violations;
- Evaluate disciplinary action for associates who violate the Code;
- In the case of more severe violations of the Code, make recommendations regarding disciplinary action to the Board of Directors or a committee thereof; and
- Evaluate the effectiveness of the Code and provide recommendations to improve the Code.

The Compliance Committee will provide a summary of all matters considered under the Code to the Board of Directors or a committee thereof at each regular meeting thereof, or sooner if warranted by the severity of the matter. All proceedings and the identity of the person reporting will be kept confidential to the extent permitted by circumstances and applicable law.

Q: If I am aware of a breach or violation of this Code, or suspect such a breach or violation, am I obligated to report it as set forth in this Code?

A: Yes, every employee, officer and director of the Company has the responsibility to ask questions, seek guidance, report known and suspected breaches or violations and express concerns regarding compliance with this Code or any of the Company's other policies. Anyone who has a reasonable basis to believe that any other employee, officer or director has engaged, or is engaging, in conduct that violates applicable law or this Code should promptly report such information through Reporting Mechanism.

Q: How can I contact the Corporate Compliance Officer, the Compliance Committee and/or the Audit Committee?

A: Reports may be made by telephone, in person, or in writing (by mail to the Company's address, by email or hand delivery). The names, phone numbers and/or email addresses of the Corporate Compliance Officer, each member of the Compliance Committee and the chairperson of the Audit Committee are listed in Appendix E. Any one of these individuals can assist you in answering questions or reporting violations or suspected violations under the Code.

The members of the Compliance Committee and the chairperson of the Audit Committee may change from time to time. You are encouraged to consult the copy of the Code that is available on the Company's website to obtain the most current membership of the Compliance Committee and the most current chairperson of the Audit Committee.

Individuals are encouraged, but not required, to leave a name and/or a contact number when submitting a report. Such information will facilitate a more thorough investigation. The members of the Compliance Committee and the chairperson of the Audit Committee will strive to maintain the integrity and confidentiality of all compliance-related communications. However, in certain circumstances, the identity of the person raising the concern may become known or need to be revealed, particularly if federal, state, local or foreign enforcement authorities become involved in the investigation. The Company cannot guarantee confidentiality when material evidence of a violation of the law is disclosed or if the person raising a concern is identified during the normal course of an investigation.

Q: How can I report any concerns that I have in a confidential and anonymous manner?

A: *You may make such reports on an anonymous and confidential basis by contacting the Whistleblower Hotline.* As specified in the Whistleblower Policy, associates may report to this service any concerns an associate may have with respect to the Company, including but not limited to, Company's business or operations, suspected violations of the Code, securities or antifraud laws, accounting issues, any law relating to fraud against shareholders, or any other issue concerning the Company and their employment with the Company. Reports made to the Whistleblower Hotline will be provided directly to the Audit Committee on an anonymous and confidential basis. Please see the description of the Reporting Mechanism above for details on contacting the Whistleblower Hotline.

II. GENERAL REQUIREMENTS

Each associate of the Company is expected to be honest, fair, and accountable in all business dealings and obligations, and to ensure:

- the ethical handling of conflicts of interest between personal and professional relationships;
- full, fair, accurate, timely and understandable disclosure in the reports required to be filed by the Company with the Securities and Exchange Commission and in other public communications made by the Company; and
- compliance with applicable governmental laws, rules and regulations.

III. CONFLICTS OF INTEREST

Associates should avoid any situation that may involve, or even appear to involve, a conflict between their personal interests and the interests of the Company. In dealings with current or potential customers, suppliers, contractors, and competitors, each associate should act in the best interests of the Company to the exclusion of personal advantage. For purposes of this section, (i) a "significant" amount or interest shall be deemed to be any amount in excess of $5,000 in aggregate, whether in connection with a single transactions or with a series of transactions in any given year and (ii) an "actual competitor" of the Company shall be deemed to be any entity selling or producing products that are similar to the Company's products. Associates are prohibited from any of the following activities which could represent an actual or perceived conflict of interest:

- No associate or immediate family member[2] of an associate shall have a significant financial interest in, or obligation to, any outside enterprise which does or seeks to do business with the Company or which is an actual or potential competitor of the Company, without prior approval of the Compliance Committee, or in the case of executive officers or members of the Board of Directors, the full Board of Directors or a committee thereof; provided however, that this provision shall not prevent any associate from investing in any mutual fund or owning up to 1% of the outstanding stock of any publicly traded Company.

- No associate shall conduct a significant amount of business on the Company's behalf with an outside enterprise which does or seeks to do business with the Company if an immediate family member of the associate is a principal or officer of such enterprise, or an employee of such enterprise who will play a significant role in the business done or to be done between the Company and such enterprise, without prior approval of the Compliance Committee, or in the case of executive officers or members of the Board of Directors, the full Board of Directors or a committee thereof.

- No executive officer or employee, or an immediate family member of an executive officer or an employee, shall serve as a director, officer or in any other management or consulting capacity of any actual competitor of the Company, without the prior approval of the full Board of Directors or a committee thereof.

- No director, or an immediate family member of a director, shall serve as a director, officer or in any other management or consulting capacity of any actual competitor of the Company, without the prior approval of the full Board of Directors or a committee thereof.

- No associate shall use any Company property or information or his or her position at the Company for personal gain.

- No associate shall engage in activities that are directly competitive with those in which the Company is engaged.

- No associate shall divert a business opportunity from the Company to such individual's own benefit. If an associate becomes aware of an opportunity to acquire or profit from a business opportunity or investment in which the Company is or may become involved or in which the Company may have an existing interest, the associate should disclose the relevant facts to the Corporate Compliance Officer or a member of the Compliance Committee. The associate may proceed to take advantage of such opportunity only if the Company is unwilling or unable to take advantage of such opportunity as notified in writing by the Compliance Committee.

---

1 When used in this Code of Conduct "immediate family member" includes any person with whom an associate has any relationship by blood, marriage, or adoption, not more remote than first cousin

- No associate or immediate family member of an associate shall receive any loan or advance from the Company, or be the beneficiary of a guarantee by the Company of a loan or advance from a third party, except for customary advances or corporate credit in the ordinary course of business or approved by the Compliance Committee. Please see Section IV.E. “Corporate Advances” below for more information on permitted corporate advances.

In addition, the Audit Committee of the Board of Directors will review and approve, in advance, all related-person transactions, as required by the Securities and Exchange Commission, The New York Stock Exchange or any other regulatory body to which the Company is subject.

Each associate should make prompt and full disclosure in writing to the Corporate Compliance Officer or a member of the Compliance Committee of any situation that may involve a conflict of interest before engaging in any conduct that may give rise to any conflict of interest. Failure to disclose any actual or perceived conflict of interest and obtain an approval or other appropriate waiver from the Compliance Committee or the Audit Committee of the Board (as applicable) is a violation of the Code.

IV. PROTECTION AND PROPER USE OF COMPANY ASSETS

Proper protection and use of Company assets and assets entrusted to it by others, including proprietary information, is a fundamental responsibility of each associate of the Company. Associates must comply with security programs to safeguard such assets against unauthorized use or removal, as well as against loss by criminal act or breach of trust. The provisions hereof relating to protection of the Company’s property also apply to property of others entrusted to it (including proprietary and confidential information).

A. Proper Use of Company Property

The removal from the Company’s facilities of the Company’s property is prohibited, unless authorized by the Company. This applies to furnishings, equipment, and supplies, as well as property created or obtained by the Company for its exclusive use – such as client lists, files, personnel information, reference materials and reports, computer software, data processing programs and databases. Neither originals nor copies of these materials may be removed from the Company’s premises or Company’s property or used for purposes other than the Company’s business without prior written authorization from the Compliance Committee.

The Company’s products and services are its property. Contributions made by any associate to their development and implementation are the Company’s property and remain the Company’s property even if the individual’s employment or directorship terminates.

Each associate has an obligation to use the time for which he or she receives compensation from the Company productively. Work hours should be devoted to activities directly related to the Company’s business.

B. Confidential Information

The Company provides its associates with confidential information relating to the Company and its business with the understanding that such information is to be held in confidence and not communicated to anyone who is not authorized to see it, except as may be required by law. The types of information that each associate must safeguard include (but are not limited to) information received from third parties in connection with the Company’s business, the Company’s plans and business strategy, non-public operational and financial performance, unannounced products and/or contracts, sales data, significant projects, customer and supplier lists, patents, patent applications, trade secrets, manufacturing techniques and sensitive financial information, whether in electronic or paper format. These are costly, valuable resources developed for the exclusive benefit of the Company. No associate shall disclose the Company’s confidential information to an unauthorized third party or use the Company’s confidential information for his or her own personal benefit.

C. Accurate Records and Reporting

Under law, the Company is required to keep books, records and accounts that accurately and fairly reflect all transactions, dispositions of assets and other events that are the subject of specific regulatory record keeping requirements, including generally accepted accounting principles and other applicable rules, regulations and criteria for preparing financial statements and for preparing periodic reports filed with the Securities and Exchange Commission. All Company reports, accounting records, sales reports, expense accounts, invoices, purchase orders, and other documents must accurately and clearly represent the relevant facts and the true nature of transactions. Reports and other documents should state all material facts of a transaction and not omit any information that would be relevant in interpreting such report or document. Under no circumstance may there be any unrecorded liability or fund of the Company, regardless of the purposes for which the liability or fund may have been intended, or any improper or inaccurate entry knowingly made on the books or records of the Company. No payment on behalf of the Company may be approved or made with the intention, understanding or awareness that any part of the payment is to be used for any purpose other than that described by the documentation supporting the payment. In addition, intentional accounting misclassifications (e.g., expense versus capital) and improper acceleration or deferral of expenses or revenues are unacceptable reporting practices that are expressly prohibited.

The Company has developed and maintains a system of internal controls to provide reasonable assurance that transactions are executed in accordance with management's authorization, are properly recorded and posted, and are in compliance with regulatory requirements. The system of internal controls within the Company includes written policies and procedures, budgetary controls, supervisory review and monitoring, and various other checks and balances, and safeguards such as password protection to access certain computer systems.

The Company has also developed and maintains a set of disclosure controls and procedures to ensure that all of the information required to be disclosed by the Company in the reports that it files or submits under the Securities Exchange Act is recorded, processed, summarized and reported within the time periods specified by the Securities and Exchange Commission's rules and forms. Please see the Company's Disclosure Controls and Procedures, Form 8-K Disclosure Compliance Policy, and the Regulation FD Disclosure Policy, all available on the Company's Intranet.

Associates are expected to be familiar with, and to adhere strictly to, these internal controls and disclosure controls and procedures.

Responsibility for compliance with these internal controls and disclosure controls and procedures rests not solely with the Company's accounting personnel, but with all associates involved in approving transactions, supplying documentation for transactions, and recording, processing, summarizing and reporting of transactions and other information required by periodic reports filed with the Securities and Exchange Commission. *Because the integrity of the Company's external reports to shareholders and the Securities and Exchange Commission depends on the integrity of the Company's internal reports and record-keeping, all associates must adhere to the highest standards of care with respect to our internal records and reporting. The Company is committed to full, fair, accurate, timely, and understandable disclosure in the periodic reports required to be filed by it with the Securities and Exchange Commission, and it expects each associate to work diligently towards that goal.*

Any associate who believes the Company's books and records are not in accord with these requirements should immediately report the matter using the Reporting Mechanism described above.

D. Document Management and Retention

Numerous federal and state statutes require the proper retention of many categories of records and documents that are commonly maintained by companies. In consideration of those legal requirements and the Company's business needs, all associates must maintain records in accordance with these laws.

Any record, in paper or electronic format, relevant to a threatened, anticipated or actual internal or external inquiry, investigation, matter or lawsuit may not be discarded, concealed, falsified, altered, or otherwise made unavailable, once an associate has become aware of the existence of such threatened, anticipated or actual internal or external inquiry, investigation, matter or lawsuit.

All associates must comply with the Company's Record Management Policy in the Company's Employee Hand Book. In addition, from time to time, the Company may adopt additional specific written policies and procedures with respect to document retention or amend existing policies and procedures. All employees will be notified if such policies and procedures are adopted or if existing policies and procedures are amended.

Any associate who believes the Company's document retention is not in accord with these requirements should immediately report the matter using the Reporting Mechanism described above.

E. Corporate Advances

Under law, the Company may not loan money to associates except in limited circumstances. It shall be a violation of the Code for any associate to advance Company funds to any other associate or to himself or herself except for usual and customary business advances for legitimate corporate purposes which are approved by a supervisor or pursuant to a corporate credit card for usual and customary, legitimate business purposes. It is the Company's policy that any advance not meeting the foregoing criteria be approved in advance by the Compliance Committee.

Company credit cards are to be used only for authorized, legitimate business purposes. An associate will be responsible for any unauthorized charges to a Company credit card. Any associate who believes the Company's corporate advances are not in accord with these requirements should immediately report the matter using the Reporting Mechanism described above.

V. FAIR DEALING WITH CUSTOMERS, SUPPLIERS, COMPETITORS, AND ASSOCIATES

The Company does not seek to gain any advantage through the improper use of favors or other inducements, including facilitation payments, involving personal financial gain or advantage to the recipient (generally referred to as bribery). Good judgment and moderation must be exercised to avoid misinterpretation and adverse effect on the reputation of the Company or its associates. Offering, giving, soliciting or receiving any form of bribe (including facilitation payments in many instances) is strictly prohibited under the laws of the various countries in which the Company operates or into which the Company's products are sold, whether the other person involved is an employee of a customer or supplier, a public official, or any other person.

A. Giving Gifts

Cash or cash-equivalent gifts must not be given by an associate to any person or enterprise, even if the cash gift is of token value. However, non-cash gifts, favors and entertainment may be given to non-governmental employees if what is given:

- is consistent with customary business practice;
- cannot be construed as a bribe, pay-off or facilitation payment;
- is not in violation of applicable law or ethical standards; and
- will not embarrass the Company or the associate if publicly disclosed.

See also subsection E below and the Anti-Corruption Policy, for considerations relating to gifts to foreign officials and Section VI. B below for considerations relating to gifts to government employees.

B. Receiving Gifts

Gifts, favors, entertainment or other inducements may not be accepted by associates or members of their immediate families from any person or organization that does or seeks to do business with, or is a competitor of, the Company, except as common courtesies usually associated with customary business practices. The Compliance

Committee, with the approval of the Audit Committee will establish reporting thresholds and approval procedures in connection with the receipt of gifts.

An especially strict standard applies when suppliers are involved. If a gift unduly influences or makes an associate feel obligated to "pay back" the other party with business, receipt of the gift is unacceptable.

It is never acceptable to accept a gift in cash or cash equivalent of any value. Cash gifts must be declined and returned to the sender.

The Company engages in ongoing risk assessment relating to bribery. If someone offers you a gift, favor, entertainment or other inducement that you think is intended or may be intended as a bribe, you are obligated to reject the offer and to report the offer using the Reporting Mechanism described above.

C. Unfair Competition

Although the free enterprise system is based upon competition, rules have been imposed stating what can and what cannot be done in a competitive environment. The following practices can lead to liability for "unfair competition" and should be avoided. They are violations of the Code.

Disparagement of Competitors. It is not illegal to point out weaknesses in a competitor's service, product or operation. However, associates may not spread false rumors about competitors or make misrepresentations about their businesses. For example, an associate may not pass on anecdotal or unverified stories about a competitor's products or services as the absolute truth (e.g., the statement that "our competitors' diagnostic testing procedures have poor quality control").

Misrepresentations of Price and Product. Lies or misrepresentations about the nature, quality or character of the Company's services and products are both illegal and contrary to Company policy. An associate may only describe our services and products based on their documented specifications, not based on anecdote or his or her belief that our specifications are too conservative.

D. Antitrust Concerns

Federal and state antitrust laws are intended to preserve the free enterprise system by ensuring that competition is the primary regulator of the economy. Every corporate decision that involves customers, competitors, and business planning with respect to output, sales and pricing raises antitrust issues. Compliance with antitrust laws is in the public interest, in the interest of the business community at large, and in our Company's interest.

Failing to recognize antitrust risk is costly. Antitrust litigation can be very expensive and time-consuming. Moreover, violations of the antitrust laws can, among other things, subject you and the Company to the imposition of injunctions, treble damages, and heavy fines. Criminal penalties may also be imposed, and individual employees can receive heavy fines or even be imprisoned. For this reason, antitrust compliance should be taken seriously at all levels within the Company.

A primary focus of antitrust laws is on dealings between competitors. In all interactions with actual or potential competitors all associates must follow these rules:

- Never agree with a competitor or a group of competitors to charge the same prices or to use the same pricing methods, to allocate services, customers, private or governmental payer contracts or territories among yourselves, to boycott or refuse to do business with a provider, vendor, payer or any other third party, or to refrain from the sale or marketing of, or limit the supply of, particular products or services.

- Never discuss past, present, or future prices, pricing policies, bundling, discounts or allowances, royalties, terms or conditions of sale, costs, choice of customers, territorial markets, production quotas, allocation of customers or territories, or bidding on a job with a competitor.

- Be careful of your conduct. An “agreement” that violates the antitrust laws may be not only a written or oral agreement, but also a “gentlemen’s agreement” or a tacit understanding. Such an “agreement” need not be in writing. It can be inferred from conduct, discussions or communications of any sort with a representative of a competitor.
- Make every output-related decision (pricing, volume, etc.) independently, in light of costs and market conditions and competitive prices.
- Carefully monitor trade association activity. These forums frequently create an opportunity for competitors to engage in antitrust violations.

Another focus of antitrust law is how a Company deals with customers, suppliers, contractors and other third parties. The following practices could raise issues, and associates should always consult with the Corporate Compliance Officer or the Compliance Committee before doing any of the following:

- Refuse to sell to any customers or prospective customer;
- Enter into any new distribution or supply agreement which differs in any respect from those previously approved;
- Condition a sale on the customer’s purchasing another product or service, or on not purchasing the product of a competitor;
- Agree with a customer on a minimum or maximum resale price of our products;
- Impose restrictions on the geographic area to which our customers may resell our products;
- Require a supplier to purchase products from the Company as a condition of purchasing products from that supplier;
- Enter into an exclusive dealing arrangement with a supplier or customer; or
- Offer different prices, terms, services or allowances to different customers who compete or whose customers compete in the distribution of commodities.

If our Company has a dominant or potentially dominant position with respect to a particular product or market, especially rigorous standards of conduct must be followed. In these circumstances, all associates should:

- Consult with the Corporate Compliance Officer or the Compliance Committee before selling at unreasonably low prices or engaging in any bundling practices; and
- Keep the Corporate Compliance Officer or the Compliance Committee fully informed of competitive strategies and conditions in any areas where the Company may have a significant market position.

Finally, always immediately inform the Corporate Compliance Officer or the Compliance Committee if local, state or federal law enforcement officials request information from the Company concerning its operations.

E. Unfair Practices in International Business

The Company and its associates must comply at all times with all anti-corruption, anti-bribery and anti-kickback laws, rules and regulations in each jurisdiction in which the Company operates. In complying with the potentially overlapping and/or conflicting laws, rules and regulations of various jurisdictions, the Company and its associates should always adhere to and seek to follow the most stringent set of laws, rules and regulations to which it or they may be subject.

Under the U.S. Foreign Corrupt Practices Act ("**FCPA**"), associates of the Company are prohibited from making certain gifts to foreign officials. "Foreign officials" include not only persons acting in an official capacity on behalf of a foreign government, agency, department or instrumentality, but also representatives of international organizations, foreign political parties and candidates for foreign public office. The gift is "corrupt" under the FCPA if it is made for the purpose of gaining any "improper advantage" by:

- influencing any act or decision of a foreign official in his official capacity;
- inducing a foreign official to do or omit to do any act in violation of his lawful duty; or
- inducing a foreign official to use his position to affect any decision of the government;

A gift is still "corrupt" even when paid through an intermediary. No associate may offer or give any gift to a foreign government official without the advance written approval of the Corporate Compliance Officer. Associates must also be familiar with and abide by the Company's Anti-Corruption Policy.

In addition to the FCPA, the United Kingdom's Bribery Act 2010 ("**Bribery Act**") may apply under various circumstances. The Bribery Act prohibits much of the same conduct as the FCPA but, in contrast to the FCPA, the Bribery Act also prohibits soliciting or receiving bribes and applies to bribery that does not involve a foreign official (for example, bribery that occurs between two employees of private businesses). Violating the Bribery Act could expose you (and in certain cases, the Company) to criminal as well as civil liability, including potentially fines and imprisonment.

VI. GOVERNMENT RELATIONS

Associates must adhere to the highest standards of ethical conduct in all relationships with government employees and must not improperly attempt to influence the actions of any public official.

A. Government Procurement

The U.S. Government and many state and local governments have adopted comprehensive laws and regulations governing their purchases of products from private contractors. These laws and regulations are intended to assure that governmental entities receive pricing, terms, and conditions equivalent to those granted to the Company's most favored commercial customers and that there is full and open competition in contracting. The procurement integrity laws impose restrictions on the relationships between the Company and government procurement officials who have or are engaged personally and substantially in government procurements. Prohibited activities include: (i) offering, discussing, or accepting post-government employment or business opportunities; or (ii) soliciting, obtaining, or disclosing any bid or proposal information, proprietary or source selection information from competitors or government officials. Employees working on projects for which the ultimate customer is the U.S. Government must have a working knowledge of and comply with the regulations and laws that govern the acquisition of goods and services by the U.S. Government. Associates should also ensure that business partners, suppliers, and consultants are aware of and, to the extent practical, in compliance with, these legal requirements.

When selling products or services to government procurement agencies, the Company is accountable for certifying compliance with applicable procurement laws, regulations, and requirements. Certifications to, and contracts with, government agencies are to be signed by a Company associate authorized by the Board of Directors to sign such documents, based upon knowledge that all requirements have been fully satisfied.

B. Payments to Officials

Under no circumstances should associates make payments or give gifts to officials or employees of the United States Government or any foreign government. Corporate hospitality and the reimbursement of travel expenses involving government officials or employees should be limited to bona fide expenses relating to the legitimate promotion of the Company's products and services and in most instances should be approved in advance both by the Corporate Compliance Officer and the government organization that employs the person in question.

C. Political Contributions

Company funds, property or services may not be contributed to any political party or committee, or to any candidate for or holder of any office of any government. This policy does not preclude, where lawful, Company expenditures to support or oppose public referendum or separate ballot issues, or, where lawful, the formation and operation of a political action committee, in each case, when reviewed and approved in advance by the Audit Committee and subsequently ratified by the Board of Directors.

VII. COMPLIANCE WITH LAWS, RULES AND REGULATIONS

A. Insider Trading Policy

The Company expressly forbids any associate from trading on material non-public information or communicating material non-public information to others in violation of the law. This conduct is frequently referred to as "**insider trading**." This policy applies to every associate of the Company and extends to activities both within and outside their duties to the Company, including trading for a personal account.

The concept of who is an "**insider**" is broad. It includes officers, directors and employees of a Company. In addition, a person can be a "**temporary insider**" if he or she enters into a special confidential relationship in the conduct of a Company's affairs and as a result is given access to information solely for the Company's purpose. A temporary insider can include, among others, a Company's investment advisors, agents, attorneys, accountants and lending institutions, as well as the employees of such organizations. An associate may also become a temporary insider of *another company* with which our Company has a contractual relationship, to which it has made a loan, to which it provides advice or for which it performs other services.

Trading on inside information is not a basis for liability unless the information is material. This is information that a reasonable investor would consider important in making his or her investment decisions, or information that is likely to have a significant effect on the price of a Company's securities.

Information is non-public until it has been effectively communicated to the marketplace. Tangible evidence of such dissemination is the best indication that the information is public. For example, information found in a report filed with the Securities and Exchange Commission or appearing in a national newspaper would be considered public.

Each associate should be familiar with and abide by the Company's Insider Trading Policy. A copy of this policy is available on the Company's Intranet. The Company encourages its associates to bring any problem, complaint or concern regarding any alleged insider trading to the attention of the Compliance Committee. Associates who have concerns regarding conduct they believe constitutes insider trading should also make such reports using the Reporting Mechanism described above.

B. Equal Employment Opportunity

The Company makes employment-related decisions without regard to a person's race, color, religious creed, age, sex, sexual orientation, marital status, national origin, ancestry, present or past history of mental disorder, mental retardation, learning disability or physical disability, including, but not limited to, blindness and genetic predisposition, or any other factor unrelated to a person's ability to perform the person's job. "**Employment**

decisions” generally mean decisions relating to hiring, recruiting, training, promotions and compensation, but the term may encompass other employment actions as well.

The Company encourages its associates to bring any problem, complaint or concern regarding any alleged employment discrimination to the attention of the Human Resources Department. Associates who have concerns regarding conduct they believe is discriminatory should also make such reports using the Reporting Mechanism described above.

C. Sexual Harassment Policy

The Company is committed to maintaining a collegial work environment in which all individuals are treated with respect and dignity and which is free of sexual harassment. In keeping with this commitment, the Company will not tolerate sexual harassment of associates by anyone, including any supervisor, co-worker, vendor, client or customer, whether in the workplace, at assignments outside the workplace, at Company-sponsored social functions or elsewhere.

Associates must also be familiar with and abide by the Company’s Sexual Harassment Policy in the Company’s Employee Handbook, which is available through the Company’s Intranet. The Company encourages its associates to bring any problem, complaint or concern regarding any alleged sexual harassment to the attention of the Human Resources Department. Associates who have concerns regarding conduct they believe constitutes sexual harassment should also make such reports using the Reporting Mechanism described above.

D. Health, Safety & Environment Laws

Health, safety, and environmental responsibilities are fundamental to the Company’s values. Associates are responsible for ensuring that the Company complies with all provisions of the health, safety, and environmental laws of the United States and of other countries where the Company does business.

The penalties that can be imposed against the Company and its associates for failure to comply with health, safety, and environmental laws can be substantial, and include imprisonment and fines.

Associates must also be familiar with and abide by the Company’s Safety, Health and Environment Policy, which is available on the Company’s Intranet. The Company encourages its associates to bring any problem, complaint or concern regarding any health, safety and environmental concern to the attention of the Human Resources Department. Associates who have concerns regarding health, safety and environmental issues may also make such reports using the Reporting Mechanism described above.

VIII. QUESTIONS UNDER THE CODE AND WAIVER PROCEDURES

Associates are encouraged to consult with the Corporate Compliance Officer and Compliance Committee about any uncertainty or questions they may have under the Code.

If any situation should arise where a course of action would likely result in a violation of the Code but for which the associate thinks that a valid reason for the course of action exists, the associate should contact the Corporate Compliance Officer or a member of the Compliance Committee to obtain a waiver *prior to the time the action is taken. No waivers will be granted after the fact for actions already taken***.** Except as noted below, the Compliance Committee will review all the facts surrounding the proposed course of action and will determine whether a waiver from any policy in the Code should be granted.

Waiver Procedures for Executive Officers and Directors. Waiver requests by an executive officer or member of the Board of Directors shall be referred by the Compliance Committee, with its recommendation, to the Board of Directors or a committee thereof for consideration. If either (i) a majority of the independent directors on the Board of Directors, or (ii) a committee comprised solely of independent directors agrees that the waiver should be granted, it will be granted. The Company will disclose the nature and reasons for the waiver on a Form 8-K to be filed with the Securities and Exchange Commission within four days. If the Board denies the request for a waiver, the waiver will not be granted and the associate may not pursue the intended course of action.

It is the Company's policy only to grant waivers from the Code in limited and compelling circumstances.

IX. FREQUENTLY ASKED QUESTIONS AND ANSWERS

The following questions and answers address each associate's obligation to comply with the Code. The Company has attempted to design procedures that ensure maximum confidentiality and, most importantly, freedom from the fear of retaliation for complying with and reporting violations under the Code.

Q: Do I have a duty to report violations under the Code?

A: Yes, participation in the Code and its compliance program is mandatory. You must immediately report any suspected or actual violation of the Code using the Reporting Mechanism described above. The Company will keep reports confidential to the fullest extent permitted by applicable law. Failure to report suspected or actual violations is itself a violation of the Code and may subject you to disciplinary action, up to and including termination of employment or legal action.

Q: I'm afraid of being fired for raising questions or reporting violations under the Code. Will I be risking my job if I do?

A: The Code contains a clear non-retaliation policy, meaning that if you in good faith report a violation of the Code by the Company, or its agents acting on behalf of the Company, using the Reporting Mechanism described above, the Company will undertake to protect you from being fired, demoted, reprimanded or otherwise harmed for reporting the violation, even if the violation involves you, your supervisor, or senior management of the Company. Note, however, that while you will not be disciplined for reporting a violation, you may be subject to discipline with respect to the underlying conduct or violation if you are involved. However, your willingness to cooperate will be taken into consideration. You are entitled to make the report on a confidential and anonymous basis. To the extent an investigation must be initiated, the Company will endeavor to keep confidential any report you make to the Corporate Compliance Officer or another member of the Compliance Committee to the extent permitted by applicable law.

In addition, if you in good faith report a suspected violation under the Code which you reasonably believe constitutes a violation of a federal, state, local or foreign statute by the Company, or its agents acting on behalf of the Company, to a federal, state, local or foreign regulatory or law enforcement agency, you may not be reprimanded, discharged, demoted, suspended, threatened, harassed or in any manner discriminated against in the terms and conditions of your employment for reporting the suspected violation, regardless of whether the suspected violation involves you, your supervisor or senior management of the Company.

Associates are encouraged to pursue all internal reporting channels through completion and reasonably await and consider the results of all internal investigations prior to reporting matters outside of the Company. We have instituted the procedures described in this Code, including procedures to make anonymous submissions (a form of internal report), to facilitate the use of internal investigations.

Individuals should also consider leaving, but are not required to leave, their name or a contact number when submitting a report. Such information may facilitate a more thorough and efficient investigation. The Corporate Compliance Officer will strive to maintain the integrity and confidentiality of all compliance-related communications. However, in certain circumstances, the identity of the person reporting the issue may become known or may need to be revealed, particularly if federal or state enforcement authorities become involved in the investigation. The Company cannot guarantee confidentiality when material evidence of a violation of the law is disclosed or if the person is identified during the normal course of an investigation.

Q: How are suspected violations investigated under the Code?

A: When a suspected violation is reported using the Reporting Mechanism described above (which includes as an option reporting directly to the chairperson of the Company's Audit Committee), the Compliance Committee will gather information about the allegation by interviewing the associate reporting the suspected violation, the associate who is accused of the violation and/or any co-workers or associates of the accused associates to determine if a factual basis for the allegation exists. However, depending on the nature of the suspected violation and the source of the report, the Compliance Committee should notify the Audit Committee (in cases involving executive officers) and the Audit Committee, at its discretion, may choose to investigate the suspected violation directly. The reporting associate's immediate supervisor will not be involved in the investigation if the reported violation involved that supervisor.

If the report is not substantiated, the reporting associate will be informed and at that time will be asked for any additional information not previously communicated. If there is no additional information, the Corporate Compliance Officer will close the matter as unsubstantiated.

If the allegation is substantiated, the Compliance Committee will make a judgment as to the degree of severity of the violation and the appropriate disciplinary response. In more severe cases, the Compliance Committee will make a recommendation to the Board of Directors of the Company for its approval. The Board's decision as to disciplinary and corrective action will be final. In the case of less severe violations, the Corporate Compliance Officer may refer the violation to the individual's supervisor, the Human Resources Department, or the Compliance Committee for appropriate disciplinary action, as the facts may dictate.

The Compliance Committee shall provide a summary of all matters considered under the Code to the Board of Directors or a committee thereof at each regular meeting thereof, or sooner if warranted, by the severity of the matter.

Q: Do I have to participate in any investigation under the Code?

A: Your full cooperation with any pending investigation under the Code is a condition of your continued relationship with the Company. The refusal to cooperate fully with any investigation is a violation of the Code and grounds for discipline, up to and including termination.

Q: What are the consequences of violating the Code?

A: As explained above, associates who violate the Code may be subject to discipline, up to and including termination of employment or legal action. Associates who violate the Code may simultaneously violate federal, state, local or foreign laws, regulations or policies. Such associates may be subject to prosecution, imprisonment and fines, and may be required to make reimbursement to the Company, the government or any other person for losses resulting from the violation. They may be subject to punitive or treble damages depending on the severity of the violation and applicable law.

Q: What if I have questions under the Code or want to obtain a waiver under any provision of the Code?

A: The Corporate Compliance Officer and any member of the Compliance Committee can help answer questions you may have under the Code. Particularly difficult questions will be answered with input from the Compliance Committee as a whole. In addition, Section VIII of the Code provides information on how you may obtain a waiver from the Code; waivers will be granted only in very limited circumstances. You should never pursue a course of action that is unclear under the Code without first consulting the Corporate Compliance Officer or the Compliance Committee, and if necessary, obtaining a waiver from the Code.

APPENDIX A

ASSOCIATE'S AGREEMENT TO COMPLY

I have read the Aspen Aerogels, Inc. Code of Business Conduct and Ethics (the "Code"). I have obtained an interpretation of any provision about which I had a question. I agree to abide by the provisions of the Code. Based on my review, I acknowledge that

_____ To the best of my knowledge, I am not in violation of, or aware of any violation by others of, any provision contained in the Code;

OR

_____ I have made a full disclosure on the reverse side of this acknowledgement of the facts regarding any possible violation of the provisions set forth in the Code.

In addition, I understand that I am required to report any suspected or actual violation of the Code, and that I may make such reports on a fully anonymous basis through the mechanisms described in this Code. I understand that I am required to cooperate fully with the Company in connection with the investigation of any suspected violation. I understand that my failure to comply with the Code or its procedures may result in disciplinary action, up to and including termination.

By: Date:
Name (Please print):
Department/Location:

APPENDIX B

COMPLAINTS HANDLING PROCEDURES

The Audit Committee of the Board of Directors of Aspen Aerogels, Inc. (the "Company") has established the following procedures for:

- the receipt, retention and treatment of complaints received by the issuer regarding accounting, internal accounting controls or auditing matters,
- the confidential, anonymous submission by employees of the issuer of concerns regarding questionable accounting or auditing matters,
- any other complaints alleging a violation of the Code of Business Conduct and Ethics.

1. **Receipt of Complaints.** The Audit Committee has designated the Compliance Committee (the "Recipient") as the party to be designated to receive complaints and concerns under this Policy.

2. **Transmission of Complaints to the Audit Committee.** The Audit Committee shall receive a copy or summary of any material complaint received by the Recipient as soon as practicable, in a form to be agreed upon between the Chair of the Audit Committee and the Recipient.

3. **Retention of Complaints.** The complaints received by the Recipient shall be recorded and retained in accordance with the Company's Records Retention Policy for confidential matters.

4. **Treatment of Complaints.** The complaints received by the Recipient will initially be reviewed by the Compliance Committee and based on the nature and relevance should be discussed with the Audit Committee.

5. **Anonymity of Complaints.** As required by the Act, employees are permitted to submit their concerns regarding questionable accounting or auditing matters confidentially. To the extent an investigation of any such reports must be initiated, the Company will keep the reporting employee's identity confidential to the extent required by applicable law.

APPENDIX C

WHISTLEBLOWER POLICY

APPENDIX D

ANTI-CORRUPTION POLICY

APPENDIX E

COMPLIANCE COMMITTEE AND AUDIT COMMITTEE CONTACT INFORMATION

Kelley W. Conte Corporate Compliance Officer	**(508) 466-3122** **kconte@aerogel.com**
John F. Fairbanks Compliance Committee Member	**(508) 691-1150** **jfairbanks@aerogel.com**
Christine Meyers Compliance Committee Member	**(508) 691-1119** **cmeyers@aerogel.com**
Richard F. Reilly Audit Committee chairperson	**rreilly@aerogel.com**

Exhibit 21.1

SUBSIDIARIES OF ASPEN AEROGELS, INC.

Aspen Aerogels Germany GmbH, a German entity

Aspen Aerogels Rhode Island, LLC, a Rhode Island limited liability company

Aspen Aerogels Georgia, LLC, a Georgia limited liability company

Exhibit 23.1

Consent of Independent Registered Public Accounting Firm

The Board of Directors
Aspen Aerogels, Inc.:

We consent to the incorporation by reference in the registration statements (No. 333-227158 and No. 333-221403) on Form S-3, and the registration statements (Nos. 333-230165, 333-223380, 333-216434, 333-209995 and 333-198124) on Form S-8 of Aspen Aerogels, Inc. of our report dated March 6, 2020, with respect to the consolidated balance sheets of Aspen Aerogels, Inc. and subsidiaries as of December 31, 2019 and 2018, the related consolidated statements of operations, stockholders' equity, and cash flows for each of the years in the three-year period ended December 31, 2019, and the related notes and financial statement schedule II – Valuation and Qualifying Accounts, and the effectiveness of internal control over financial reporting as of December 31, 2019, which report appears in the December 31, 2019 annual report on Form 10-K of Aspen Aerogels, Inc.

Our report refers to a change in accounting principles related to leases.

/s/ KPMG LLP

Hartford, Connecticut
March 6, 2020

Exhibit 31.1

CERTIFICATIONS UNDER SECTION 302

I, Donald R. Young, certify that:

1. I have reviewed this annual report on Form 10-K of Aspen Aerogels, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

a) designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

b) designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

c) evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

d) disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

a) all significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

b) any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: March 6, 2020

/s/ Donald R. Young
Donald R. Young
President and Chief Executive Officer
(principal executive officer)

Exhibit 31.2

CERTIFICATIONS UNDER SECTION 302

I, John F. Fairbanks, certify that:

1. I have reviewed this annual report on Form 10-K of Aspen Aerogels, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

a) designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

b) designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

c) evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

d) disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):

a) all significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

b) any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Date: March 6, 2020

/s/ John F. Fairbanks
John F. Fairbanks
Vice President, Chief Financial Officer and Treasurer
(principal financial officer and principal accounting officer)

Exhibit 32

CERTIFICATIONS UNDER SECTION 906

Pursuant to section 906 of the Sarbanes-Oxley Act of 2002 (subsections (a) and (b) of section 1350, chapter 63 of title 18, United States Code), each of the undersigned officers of Aspen Aerogels, Inc., a Delaware corporation (the “Company”), does hereby certify, to such officer’s knowledge, that:

The Annual Report for the year ended December 31, 2019 (the “Form 10-K”) of the Company fully complies with the requirements of Section 13(a) or 15(d) of the Securities Exchange Act of 1934, and the information contained in the Form 10-K fairly presents, in all material respects, the financial condition and results of operations of the Company.

Dated: March 6, 2020

/s/ Donald R. Young
Donald R. Young
President and Chief Executive Officer
(principal executive officer)

Dated: March 6, 2020

/s/ John F. Fairbanks
John F. Fairbanks
Vice President, Chief Financial Officer and Treasurer
(principal financial officer and principal accounting officer)