

AXT INC
Form 10-K
March 11, 2019
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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, 2018

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: 000-24085

AXT, INC.

(Exact name of registrant as specified in its charter)

Delaware	94-3031310
(State or other jurisdiction of incorporation or organization)	(I.R.S. Employer Identification No.)
4281 Technology Drive, Fremont, California	94538
(Address of principal executive offices)	(Zip Code)

Registrant's telephone number, including area code: (510) 438-4700

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Name of each exchange on which registered
Common	The NASDAQ Stock Market LLC
Stock,	
\$0.001	

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par value

Securities registered pursuant to Section 12(g) of the Act:

None

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

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

Indicate by checkmark 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 checkmark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K (§ 229.405 of this chapter) is not contained herein, and will not be contained, to the best of registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K.

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.

reporting company)

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 checkmark whether the registrant is a shell company (as defined in Rule 12b-2 of the Act). Yes No

The aggregate market value of the voting stock held by non-affiliates of the registrant, based upon the closing sale price of \$7.05 for the common stock on June 30, 2018 as reported on the Nasdaq Global Select Market, was approximately \$268,264,873. Shares of common stock held by each officer, director and by each person who owns 10% or more of the outstanding common stock have been excluded in that such persons may be deemed to be affiliates. This determination of affiliate status is not a conclusive determination for other purposes.

As of March 4, 2019, 39,983,959 shares, \$0.001 par value, of the registrant's common stock were outstanding.

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PART I

This Annual Report on Form 10-K (including the following section regarding Management’s Discussion and Analysis of Financial Condition and Results of Operations) contains forward-looking statements within the meaning of Section 27A of the Securities Act of 1933, as amended, and Section 21E of the Securities Exchange Act of 1934, as amended. Statements relating to our expectations regarding results of operations, market and customer demand for our products, our competitors, customer qualifications of our products, our ability to expand our markets or increase sales, emerging applications using chips or devices fabricated on our substrates, the development of new products, applications, enhancements or technologies, the life cycles of our products and applications, product yields and gross margins, expense levels, the impact of the adoption of certain accounting pronouncements, our investments in capital projects, our ability to relocate our gallium arsenide production line in a timely and orderly manner, our ability to have customers re-qualify substrates from our new manufacturing location in Dingxing, China, our ability to increase and utilize our manufacturing capacity and our belief that we have adequate cash and investments to meet our needs over the next 12 months are forward-looking statements. Words such as “expects,” “anticipates,” “intends,” “plans,” “believes,” “seeks,” “estimates,” “goals,” “should,” “continues,” “would,” “could” and similar expressions or variations of such words are intended to identify forward looking statements, but are not the exclusive means of identifying forward looking statements in this Annual Report on Form 10-K. Additionally, statements concerning future matters such as our strategy and plans, industry trends and the impact of trends, tariffs and trade wars, mandatory factory shutdowns in China, policies and regulations in China and economic cycles on our business are forward-looking statements. All forward-looking statements are based upon management’s views as of the date of this Annual Report on Form 10-K and are subject to risks and uncertainties that could cause actual results to differ materially from historical results or those anticipated in such forward-looking statements. Such risks and uncertainties include those set forth under the section entitled “Risk Factors” in Item 1A below, as well as those discussed elsewhere in this Annual Report on Form 10-K, and identify important factors that could disrupt or injure our business or cause actual results to differ materially from those predicted in any such forward-looking statements.

These forward-looking statements are not guarantees of future performance. Readers are cautioned not to place undue reliance on these forward-looking statements, which speak only as of the date hereof. Readers are urged to carefully review and consider the various disclosures made in this report, which attempt to advise interested parties of the risks and factors that may affect our business, financial condition, results of operations and prospects. We undertake no obligation to revise or update any forward looking statements in order to reflect any development, event or circumstance that may arise after the date of this report.

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Item 1. Business

AXT, Inc. (“AXT”, “the Company”, “we,” “us,” and “our” refer to AXT, Inc. and its consolidated subsidiaries) is a worldwide materials science company that develops and produces high-performance compound and single element semiconductor substrates, also known as wafers. Our consolidated subsidiaries produce and sell certain raw materials some of which are used in our substrate manufacturing process and some of which are sold to other companies.

Our substrate wafers are used when a typical silicon substrate wafer cannot meet the performance requirements of a semiconductor or optoelectronic device. The dominant substrates used in producing semiconductor chips and other electronic circuits are made from silicon. However, certain chips may become too hot or perform their function too slowly if silicon is used as the base material. In addition, optoelectronic applications, such as LED lighting and chip-based lasers, do not use silicon substrates because they require a wave form frequency that cannot be achieved using silicon. Alternative or specialty materials are used to replace silicon as the preferred base in these situations. Our wafers provide such alternative or specialty materials. We do not design or manufacture the chips. We add value by researching, developing and producing the specialty material wafers. We have two product lines: specialty material substrates and raw materials integral to these substrates. Our compound substrates combine indium with phosphorous (indium phosphide: InP) or gallium with arsenic (gallium arsenide: GaAs). Our single element substrates are made from germanium (Ge).

Our raw materials include both raw gallium and purified gallium. We use purified gallium in producing our GaAs substrates and sell both raw gallium and purified gallium in the open market to other companies for use in producing magnetic materials, high temperature thermometers, single crystal ingots, including gallium arsenide, gallium nitride, gallium antimonide and gallium phosphide ingots, and other materials and alloys. We also produce pyrolytic boron nitride (pBN) crucibles used in the high temperature (typically in the range 500 C to 1,500 C) growth process of single crystal ingots and epitaxial layer growth in MBE (Molecular Beam Epitaxy) reactors. We use these pBN crucibles in our own ingot growth processes and also sell them in the open market to other companies. Our substrate product group generated 79%, 80% and 81% of our revenue and our raw materials product group generated 21%, 20% and 19% for 2018, 2017 and 2016, respectively.

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The following chart shows our substrate products and their materials, diameters and illustrative applications and shows our raw materials group primary products and their illustrative uses and applications.

Products	Wafer Diameter	Sample of Applications
Substrate Group		
Indium Phosphide (InP)	2", 3", 4"	<ul style="list-style-type: none"> • Fiber optic lasers and detectors • Passive Optical Networks (PONs) • Data center connectivity using light/lasers • Silicon photonics • Photonic Integrated circuits (PICs) • High efficiency terrestrial solar cells (CPV) • RF amplifier and switching • Infrared light-emitting diode (LEDs) motion control • Infrared thermal imaging
Gallium Arsenide (GaAs - semi-insulating)	1", 2", 3", 4", 5", 6"	<ul style="list-style-type: none"> • Power amplifiers for wireless devices • Direct broadcast television • High-performance transistors • Satellite communications • High efficiency solar cells for drones and automobiles
Gallium Arsenide (GaAs - semi-conducting)	1", 2", 3", 4", 5", 6"	<ul style="list-style-type: none"> • 3-D sensing using VCSELs • Data center communication using VCSELs • High brightness LEDs • Lasers • Near-infrared sensors • Printer head lasers and LEDs • Laser machining, cutting and drilling • Optical couplers • High efficiency solar cells for drones and automobiles • Night vision goggles
Germanium (Ge)	2", 4", 6"	<ul style="list-style-type: none"> • Satellite solar cells • Optical sensors and detectors • Terrestrial concentrated photo voltaic (CPV) cells • Multi-junction solar cells for satellites • Infrared detectors
Raw Materials Group		
4N raw gallium		<ul style="list-style-type: none"> • Magnetic materials • High temperature thermometers • Low melting point alloys • Optical glass • Infrared detectors
6N+ purified gallium		<ul style="list-style-type: none"> • Key material in single crystal ingots such as: <ul style="list-style-type: none"> - Gallium Arsenide (GaAs) - Gallium Nitride (GaN) - Gallium Antimonide (GaSb) - Gallium Phosphide (GaP)
Boron trioxide (B2O3)		

Gallium-Magnesium alloy	<ul style="list-style-type: none">• Encapsulant in the ingot growth of III-V compound semiconductors
pyrolytic boron nitride (pBN) crucibles	<ul style="list-style-type: none">• Used for the synthesis of organo-gallium compounds in epitaxial growth on semiconductor wafers• Used when growing single-crystal compound semiconductor ingots
pBN insulating parts	<ul style="list-style-type: none">• Used when growing epitaxial layers in MBE reactors• Metal-Organic Chemical Vapour Deposition (MOCVD) reactors and organic light-emitting diode (OLED) rings

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We manufacture all of our products in the People's Republic of China (PRC or China), which generally has favorable costs for facilities and labor compared with comparable facilities in the United States, Europe or Japan. Our supply chain includes partial ownership of 10 companies in China (subsidiaries/joint ventures). We believe this supply chain arrangement provides us with pricing advantages, reliable supply, market trend visibility and better sourcing lead-times for key raw materials central to manufacturing our substrates. Our subsidiaries and joint venture companies produce materials, including raw gallium (4N Ga), high purity gallium (6N Ga), arsenic, germanium, germanium dioxide, pyrolytic boron nitride (pBN) crucibles and boron oxide (B₂O₃). Our ownership and the ownership held by our consolidated subsidiaries in these companies range from 97% to 20%. We have board representation in all 10 of these companies. We consolidate the companies in which we have either a controlling financial interest, or majority financial interest combined with the ability to exercise substantive control over the operations, or financial decisions, of such companies. We use the equity method to account for companies in which we have smaller financial interest and have the ability to exercise significant influence, but not control, over such companies. We purchase portions of the materials produced by these companies for our own use and they sell the remainder of their production to third parties.

The Beijing city government is moving its offices into the area where our original manufacturing facility is currently located and is in the process of moving thousands of government employees into this area. The government has constructed showcase tower buildings and overseen the establishment of new apartment complexes, retail stores and restaurants. An amusement park is being constructed within a few miles of our facility. To create room and upgrade the district, the city instructed virtually all existing manufacturing companies, including AXT, to relocate all or some of their manufacturing lines. In 2018, we achieved every major milestone established in the relocation of our gallium arsenide and germanium production lines. We intend to secure additional permits and approvals in 2019. The new facilities give us the long-term capacity and a new level of technological sophistication in our manufacturing capabilities to support the major trends that we believe are likely to drive demand for our products in the years ahead. Our indium phosphide production line, as well as various administrative and sales functions will remain primarily at our original site in the near future.

To mitigate our risks and maintain our production schedule, we are moving our gallium arsenide equipment in stages so that we will continue to produce our gallium arsenide products at our Beijing site, and then subsequently transfer increasing volume to the new sites. This approach will also minimize any disruption to our customers. We intend to complete this relocation in 2019. In 2018, we provided qualification wafers and our own internal characterization data from the new facilities to our customers. Our major customers are in the process of qualifying the wafer substrates before placing volume purchase orders for products from the new facilities. The relocation of our gallium arsenide production line requires us to continue to accurately execute our relocation plan. A failure to properly complete our relocation plan could result in disruption to our production and have a material adverse impact on our revenue, our results of operations and our financial condition. If we fail to meet the product qualification requirements of a customer, we may lose sales to that customer. Our reputation may also be damaged. Any loss of sales could have a material adverse effect on our revenue, our results of operations and our financial condition.

On September 24, 2018, the Trump Administration announced a list of thousands of categories of goods that will face tariffs of 10%. All of our wafer substrates are manufactured in China and for the year ended December 31, 2018, approximately 10% of our revenue was generated by sales to customers in North America, primarily in the U.S. Our inbound products to the U.S. are now subject to a 10% tariff assessed on the customs value of the goods as imported

by us, effective approximately September 24, 2018. Although we do not believe the initial impact of approximately \$150,000 per quarter is material, the future impact of tariffs and trade wars is uncertain. The tariffs could be increased to 25% sometime in the future. We may be required to raise prices, which may result in the loss of customers and our business, financial condition and results of operations may be materially harmed. Additionally, the Trump Administration continues to signal that it may alter trade agreements and terms between China and the United States, including limiting trade with China, and may impose additional tariffs on imports from China.

We were incorporated in California in December 1986 and reincorporated in Delaware in May 1998. The Company went public in 1998. We changed our name from American Xtal Technology, Inc. to AXT, Inc. in July 2000. Our principal corporate office is located at 4281 Technology Drive, Fremont, California 94538, and our telephone number at this address is (510) 438-4700. We have approximately 780 employees. In addition, our three consolidated

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subsidiaries have, in total, approximately 300 employees. In aggregate, we and our subsidiaries have approximately 1080 employees.

Industry Background

Certain electronic and opto-electronic applications have performance requirements that exceed the capabilities of conventional silicon substrates, also known as wafers, and often require high-performance compound wafers (mixture of two materials) or single element wafer substrates. Examples of higher performance non-silicon based wafer substrates include GaAs, InP, gallium nitride (GaN), silicon carbide (SiC) and Ge. One of the earliest broadly used alternative wafer substrates was GaAs and GaAs wafer substrates were the earliest wafer substrates we produced.

Semi-insulating GaAs is used to create various high speed microwave components, including power amplifier chips used in cell phones, satellite communications and broadcast television applications. Semi-conducting GaAs substrates are used to create opto-electronic products, including high brightness light-emitting diodes (HBLEDs) that are often used to backlight wireless handsets and liquid crystal display (LCD) TVs and also used for automotive panels, signage, display and lighting applications. A new application for semi-conducting GaAs is 3-D sensing chips using VCSELs (vertical cavity surface emitting lasers) as an array of lasers on a single chip that could be used in cell phones and other devices. InP is a high performance semiconductor substrate used in broadband and fiber optic applications and data center connectivity. In recent years, InP demand has increased. Ge substrates are used in applications such as solar cells for space and terrestrial photovoltaic applications.

The AXT Advantages

We believe that we benefit from the following advantages:

- Key leadership in InP technology and revenue growth. We have invested in InP research and development for a number of years and have developed a strong base of proprietary technology that we continue to expand. There are significant barriers to entry in the InP substrate market and currently there are only three primary providers, including AXT. Further, we believe that this market will continue to expand and grow and we have been adding capacity to take advantage of this expansion.
- Key provider of low defect density GaAs which can be used to make 3-D sensing chips. The deployment of 3-D sensing facial recognition technology in cell phones and other devices requires GaAs substrates with low etch pit density (“EPD”) (i.e., low defect densities). The requirement of low EPD is a barrier to entry and we believe there are a limited number of potential substrate providers that can meet this requirement, which includes AXT. Several companies in Asia are already using our low EPD wafers for development although we are not yet selling wafers into the one program that we believe is in production. However, when we qualify low EPD wafers from our new location, we believe the quality of our low EPD wafers and our ability to expand manufacturing capacity quickly will enable us to support new applications and generate additional revenue.
- Proprietary process technology drives manufacturing. In our industry, the single crystal growth process and the wafer manufacturing process incorporate proprietary process technology. We have a substantial body of proprietary process technology and this creates a barrier to entry as evidenced by the small number of suppliers of InP wafers or GaAs low EPD wafers.
- Low-cost manufacturing operation in China. Since 2004, we have manufactured all of our products in China, which generally has favorable costs for facilities and labor compared to costs of comparable facilities and labor in the United States, Japan or Europe. As of December 31, 2018, approximately 1,053 of our 1,080 employees (including employees at our Beijing and Dingxing facilities as well as our consolidated joint venture companies) were located in China. Our primary competitors have their major manufacturing operations in Germany or Japan. Our presence in China also enables us to closely manage our raw materials supply chain.

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- We are experienced at adding capacity quickly to take advantage of growing and changing market trends. In recent years, we have quickly added capacity for InP substrates, enabling us to grow that business. We believe that expansion is less difficult in China than in Japan or Germany where our major competitors are located. High volume emerging market applications may require rapid expansion and we believe we are well-positioned to respond to increased demand.
- We are the only compound semiconductor substrate supplier to have a position in raw materials. We have partial ownership of 10 companies in China that form an integral part of our supply chain. We believe our subsidiaries and joint venture companies in China provide us with a more reliable supply of, and shorter lead-times for, the raw materials central to our final manufactured products compared to third party providers. We believe that this dedicated supply chain will enable us to meet increases in demand from our customers by providing an increased volume of raw materials quickly, efficiently and cost effectively.
- Our diverse product offering results in a broader range of customers and applications. We offer a diverse range of products. We are able to provide custom defined products that meet our customers' specifications and we have the technical sales support team to engage with our customers and understand their product requirements. A significant percentage of the members of our team that engage with customers have PhDs in physics or materials science. Our product diversity gives us a greater opportunity to expand our business into new applications and markets, generating more revenue.
- Enhanced revenue diversity through the sale of raw materials. Because our strategy allows our consolidated subsidiaries to also sell raw materials in the open market to third parties, approximately one fifth of our total sales are from non-substrate products, providing further diversity in our customer base and business model.
- Business model unique among current competitors. We believe we are the only publicly traded company producing InP, GaAs and Ge wafer substrates. Our direct competitors are either privately owned companies or divisions within very large companies that are publicly listed in Japan. We believe the combination of access to U.S. capital markets, U.S.-based product quality standards, but China-based manufacturing and a unique strategy for the supply of many of the raw materials we need is a competitive advantage as well as an attractive business model to our customers.

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Strategy

Our goal is to become the leading worldwide supplier of high-performance compound and single element semiconductor substrates. Key elements of our strategy include:

Promote our strengths in InP. As cloud-based data centers continue to combine integrated circuits and InP-based lasers to transfer data through light, we believe there could be increased demand for InP substrates. We believe there are also other possible applications for InP substrates in the future, which could include driverless cars, 5G cell phones and infrastructure.

Add InP capacity and continue InP R&D. We are continuing to add manufacturing capacity for InP to support our growth for this product line. Our wafer substrate products often have long product life cycles and we believe the InP product life cycle could be similar to the long product life cycle of GaAs. In addition to adding manufacturing capacity, we are continuing to invest in InP crystal growth technology and wafer processing technology. For example, we are developing six-inch diameter ingots and improving the relative flatness of the wafer surface to improve performance.

Position AXT to benefit from 3-D sensing applications in mobile devices. The GaAs substrate requirements for 3-D sensing/facial recognition applications include very low defect densities or etch pitch densities. We are continuing to develop semi-conducting GaAs six-inch diameter wafers with low EPD to support such applications.

Establish the ability to rapidly add GaAs capacity. The relocation of our GaAs manufacturing lines presents a strategic opportunity to ensure our ability to increase capacity at our new site in the future should market demands justify such capacity expansion.

Offer diverse products, including custom products. We believe AXT has a reputation in the market for providing a broad range of products, including custom products that are supported by a team of technical sales support professionals, the majority of whom hold advanced graduate degrees in physics or materials science. We plan to further promote this brand image as a way to differentiate ourselves in the market. We believe this strategy will lead to a more diverse customer base.

Sustain manufacturing efficiencies. We seek to continue to leverage our China-based manufacturing advantage by increasing efficiencies in our manufacturing methods, systems and processes. Our strategy is to combine the benefits of U.S.-based quality control and access to U.S. capital markets with our China-based manufacturing operations.

Increase productivity and seek profitability in our 10 subsidiaries/joint venture companies. The supply and demand equation for specialty materials can be complex and volatile. Over the years, we have established or invested in 10 companies that are an integral part of our supply chain. We will continue to provide strategic support to these companies and they, in turn, will continue to be the backbone of our supply chain. We plan to work closely with these companies to increase their productivity and improve their financial performance as they continue to support our supply chain.

Materials of the future. The specialty materials substrate market is dynamic and subject to continued changes and cycles. We plan to use our deep knowledge and experience in specialty materials and wafer substrates to seek new applications for existing substrates in our portfolio and explore additional materials that may be synergistic with our knowledge base, customer needs and manufacturing lines.

Technology

Wafers serve as a cornerstone in semiconductor device fabrication, on which integrated circuits and optical devices are fabricated. Wafers are derived from semi-conducting ingots that are grown in a cylindrical form. The diameter and length of an ingot will vary depending on the type of material and the growth process used. An ingot may be either single-crystalline (also referred to as single element) or multi-crystalline (also referred to as compound

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elements). Single-crystalline wafers typically have better material parameters. Depending on physical properties of the materials in a wafer, the performance of devices and circuits can be remarkably different.

AXT uses its proprietary vertical gradient freeze (VGF) technology for growing single crystal Indium Phosphide (InP), Gallium Arsenide (GaAs) and Germanium (Ge) ingots. After growing the crystalline ingot, the ingot is then sliced into individual substrates or wafers. Before specialty material wafers can be used, a thin layer of structured chemicals is grown on the surface of the substrate. This is called an epitaxial layer. We sell the majority of our substrates to companies that specialize in applying the epitaxial layer. The wafers are then used to produce state-of-the-art electronic and opto-electronic devices and circuit applications.

InP and GaAs semi-conducting compounds are formed by combining elements from Groups III and V in the periodic table of elements, whereas Ge is a Group IV elemental material. Each of these materials has unique properties that determine the best device and/or circuit applications. As a result of their special high electron mobility combined with their direct band-gap properties, both InP and GaAs wafers have enjoyed dominant roles in the production of light-emitting diodes (LEDs), solid-state lasers and power amplifiers for mobile phones, to name a few applications. Ge wafers, on the other hand, have played a key role in the manufacturing of special solar cells known as triple junction solar cells (TJSCs) for space and terrestrial power generation.

With the recent evolution in several applications, InP lasers are projected to play a dominant role in the optoelectronics arena, e.g. silicon photonics (where InP lasers are a key component) and autonomous cars (where special wavelength InP-based lasers are used for object sensing and collision avoidance). Crystal growth process technology frequently contains steps and procedures that are considered proprietary secrets held by the producer, often including methods to control the temperature within the crucible. InP crystal growth relies on extreme pressure within the crucible. As such it requires not only temperature control methodologies, but also pressure control and stabilization process methodologies, many of which AXT considers proprietary trade secrets. It is this combination of variables and the required methods to control them that create a barrier to entry. We believe our long-term investment in InP research and development has resulted in a substantive body of proprietary knowledge.

After growing the crystalline ingot, the material is then sliced into individual substrates or wafers. We have continued to invest in wafer processing technology covering each step in the process from sawing to edge smoothing to final cleaning and we believe we have technology and trade secrets addressing the scope of wafer processing. One focus in our recent development programs has been on automation, particularly in cleaning the wafers.

Ideally, all the atoms in a wafer or substrate are arrayed in a specific periodic order. However, sensitivities in the ingot growth process will cause some atoms to be improperly aligned and these are referred to as dislocations. The aggregate number of dislocations in a wafer is referred to as the dislocation density. Dislocation densities can be seen as a group of tiny marks or pits under a microscope by etching the wafer with acid and each wafer has an etch pit density or EPD. Certain micro devices, such as the array used for 3-D sensing, require wafers with very low EPD. AXT considers the process technology we use to achieve low EPD as proprietary process technology and we believe we are one of only a few substrate manufacturing companies that can produce low EPD wafers.

Products

We have two product lines: specialty material substrates and raw materials integral to these substrates. We design, develop, manufacture and distribute high-performance semiconductor substrates, also known as wafers. Through our subsidiaries in our supply chain, we also sell certain raw materials. InP is a high-performance semiconductor substrate used in fiber optic lasers and detectors, passive optical networks (PONs), telecommunication, metro and data center connectivity, silicon photonics, photonic ICs (PICs), terrestrial solar cell (CPV), lasers, RF amplifiers (military wireless), infrared motion control and infrared thermal imaging. We make semi-insulating GaAs substrates used in

making semiconductor chips in applications such as power amplifiers for wireless devices, high-performance transistors and high efficiency solar cells for drones. Our semi-conducting GaAs substrates are used to create opto-electronic products, which include High Brightness LEDs that are often used to backlight wireless handsets and LCD TVs and for automotive, signage, display and lighting applications, as well as high power industrial lasers for material processing (welding, cutting, drilling, soldering, marking and surface modification). Our semi-conducting GaAs substrates could be

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used to create opto-electronic products for 3-D sensing using VCSELs. Ge substrates are used in emerging applications, such as triple junction solar cells for space and terrestrial photovoltaic applications and for optical applications.

Substrates. We currently sell compound substrates manufactured from InP and GaAs, as well as single element substrates manufactured from Ge. We supply InP substrates in two-, three and four-inch diameters, and Ge substrates in two-, four- and six-inch diameters. We supply both semi-insulating and semi-conducting GaAs substrates in one-, two-, three, four-, five- and six-inch diameters. Many of our customers require customized specifications, such as special levels of iron or sulfur dopants or a special wafer thickness.

Raw Materials. Our consolidated subsidiaries produce and sell certain raw materials, some of which are used in our substrate manufacturing process and some of which are sold to other companies. Our raw materials include both raw gallium and purified gallium. We use purified gallium to produce our GaAs substrates and sell both raw gallium and purified gallium in the open market to other companies for use in magnetic materials, high temperature thermometers and single crystal ingots, including gallium arsenide, gallium nitride, gallium antimonide, gallium phosphide and other materials and alloys. We also produce pBN crucibles used in the high temperature (typically in the range 500 C to 1,500 C) growth process of single crystal ingots and epitaxial layer growth in MBE reactors. We use these pBN crucibles in our own ingot growth processes and also sell them in the open market to other companies.

We promote our product diversity as a way to differentiate ourselves in the market. Some competitors provide only gallium arsenide substrates. We provide gallium arsenide and also indium phosphide and germanium substrates. Some competitors limit their wafer diameters to only a few sizes. Our wafers range from one inch to up to six inches in diameter. We also produce substrates with customer defined specifications, which may range in thickness, smoothness or flatness and may include adding special additional materials, such as iron or sulfur. In addition to our wafers or substrates, we also generate revenue from our consolidated subsidiaries that sell raw materials. Product diversity can mitigate some of the down cycles in our market because we are not dependent on a single product or application for revenue.

Customers

Before specialty material wafers can be processed in a typical wafer manufacturing facility that constructs the electronic circuit, laser or optical device on a chip, a thin layer of structured chemicals is grown on the surface of the substrate. This is called an epitaxial layer. We sell our substrates to companies that apply the epitaxial layer, who then in turn sell the modified wafers to the wafer fabs, chip design companies, LED manufacturers and others. Some customers do both the epitaxial layer and wafer fabrication.

Epitaxial layer companies that form our customer base are located in Asia, the United States and Europe. We also sell our products to universities and other research organizations that use specialty materials for experimentation in various aspects of semi-conducting and semi-insulating applications. Our customers that purchase raw materials are located in Asia, the United States and Europe.

We have at times sold a significant portion of our products in any particular period to a limited number of customers. One customer, Landmark represented 13% of our revenue for the year ended December 31, 2018. Two customers, Landmark and Osram, represented 12% and 11%, respectively, of our revenue for the year ended December 31, 2017. No customer represented more than 10% of our revenue for the year ended December 31, 2016. Our top five customers, although not the same five customers for each period, represented 35% of our revenue for each of the years ended December 31, 2018, 2017 and 2016, respectively.

For each of the years ended December 31, 2018 and 2017, three customers with our consolidated subsidiaries, in aggregate, accounted for over 30% of raw material sales. For the year ended December 31, 2016, four customers with our consolidated subsidiaries, in aggregate, accounted for over 40% of raw material sales. Our subsidiaries and joint ventures are a key strategic benefit for us as they further diversify our sources of revenue.

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Manufacturing, Raw Materials and Supplies

We manufacture all of our products in China. We believe this location generally has favorable costs for facilities and labor compared to the United States or compared to the location of some of our competitors in Japan and Germany.

We use a two-stage wafer manufacturing process. The first stage deploys our VGF technology for the crystal growth of single element or compound element ingots in diameters currently ranging from one inch to six inches. The growth process occurs in high temperature furnaces built using our proprietary designs. Growing the crystalline elements into cylindrical ingots takes a number of days, depending on the diameter and length of the ingot produced. The crystal growth stage utilizes AXT proprietary process technology. The second stage includes slicing or sawing the ingot into wafers or substrates, then processing each substrate to strict specifications, including grinding to reduce the thickness and then polishing, beveling the edges and cleaning each substrate. Many of the wafer processing steps use chemical baths and properly cleaning the wafer is a critical process. The wafer processing stage also utilizes AXT proprietary process technology.

Wafers from each ingot will include some material that does not meet specifications or quality standards. Defects may occur as a result of inherent factors in the materials used in the crystalline growth process. They may also result from variances in the manufacturing process. We have many steps in our line that are partially or fully automated but other manufacturing steps are performed manually. We intend to increase the level of automation, particularly in cleaning the wafers. In 2015, we purchased wafer processing equipment from Hitachi Metals to help us increase automation in our production line and, therefore, reduce variability and defects. In addition, we secured a manufacturing license from Hitachi Metals. This license includes detailed work instructions for using the equipment purchased and allows us to apply the licensed proprietary wafer processing technology at any step and on any form of equipment in our line. Due to potential defects, yield is a key factor in our manufacturing cost. Other key elements are the initial cost of the raw material elements, manufacturing equipment, factory loading, facilities and labor.

We have 10 partially owned subsidiaries and joint ventures companies in China that form the backbone of our supply chain model. These companies provide us with reliable supply, market trend visibility, and shorter lead-times for raw materials central to our manufactured products, including gallium, gallium alloys, indium phosphide poly-crystal, arsenic, germanium, germanium dioxide, high purity arsenic, pBN and boron oxide. We believe that these subsidiaries and joint ventures have been and will continue to be advantageous in allowing us to procure materials to support our planned growth. In addition, we purchase supply parts, components and raw materials from several other domestic and international suppliers. We depend on a single or limited number of suppliers for certain critical materials used in the production of our substrates, such as quartz tubing, arsenic and polishing solutions. We generally purchase our materials through standard purchase orders and not pursuant to long-term supply contracts.

Sales and Marketing

We sell our substrate products directly to customers through our direct salesforce in the United States, China and Europe. We use independent sales representatives and distributors in Japan, Taiwan, Korea and other areas. Our direct salesforce is knowledgeable in the use of compound and single element substrates. Specialty material wafers are scientifically complicated. Our application engineers must work closely with customers during all stages of our wafer substrate manufacturing process, from developing the precise composition of the wafer substrate through manufacturing and processing the wafer substrate to the customer's specifications. We believe that maintaining a close relationship with customers and providing them with engineering support improves customer satisfaction and provides us with a competitive advantage in selling. A significant percentage of the members of our technical sales support team who frequently engage with customers have PhDs in physics or materials science.

International Sales. International sales are a substantial part of our business. Sales to customers outside North America (primarily the United States) accounted for approximately 90%, 91% and 90% of our revenue during 2018, 2017 and 2016, respectively. The primary markets for sales of our substrate products outside of North America are to customers located in Asia and Western Europe. We occasionally receive small orders from customers located in Israel and Russia.

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Our subsidiaries and joint venture companies sell specialty raw materials including 4N, 5N, 6N, 7N and 8N gallium, boron oxide, germanium, arsenic, germanium dioxide, pyrolytic boron nitride crucibles used in crystal growth, parts for MBE and parts used in manufacturing OLED rings. These subsidiaries and joint ventures have their own separate sales forces and sell directly to their own customers in addition to selling raw materials to us.

Research and Development

To maintain and improve our competitive position, we focus our research and development efforts on designing new proprietary processes and products, improving the performance of existing products, achieving new lows in EPD, increasing yields and reducing manufacturing costs. We also conduct research and development focusing on larger diameter wafers and, in our history, we have consistently developed new products based on larger wafer diameters. Crystal growth of specialty earth materials becomes significantly more difficult as the ingot diameter increases because a consistent temperature, and in the case of InP, consistent control of pressure, must be applied over a larger surface area. In 2015, we acquired certain proprietary InP crystal growth technology and equipment from Crystacomm.

Certain micro devices, such as the array used for 3-D sensing, require GaAs wafers with very low etch pit density. In anticipation of a growth in demand for low EPD six-inch wafers, we have focused our development efforts on increasing our yield of such wafers.

Our current substrate research and development activities focus on continued development and enhancement of GaAs, InP and Ge substrates, including improved yield, enhanced surface and electrical characteristics and uniformity, greater substrate strength and increased crystal length. In 2015, we acquired proprietary wafer processing equipment from Hitachi Metals. The Hitachi Metals purchase includes a license covering the use of the proprietary equipment and Hitachi Metals' proprietary wafer processing technology. A particular focus of the equipment and process technology is on cleaning the wafers. It is important to remove any residual cleaning agents from each wafer to ensure that the epitaxial growth process is not encumbered by residual chemicals on the wafer.

Our three consolidated subsidiaries conduct research and development, focusing on gallium alloys, gallium refinement and pyrolytic boron nitride crucibles used in high temperature crystal growth.

We have assembled a multi disciplinary team of skilled scientists, engineers and technicians to meet our research and development objectives. Research and development expenses were \$5.9 million in 2018, compared with \$4.8 million in 2017 and \$5.9 million in 2016. Wafer substrate research and development increased in 2018 and this increase was offset by a decrease in one of our three consolidated subsidiaries. Development work focusing on yield improvement and other matters related to our research and development efforts also occurs within regular manufacturing processes. These costs are included in our cost of revenue because it is difficult to isolate them as research and development.

Competition

The semiconductor substrate industry is characterized by narrow technological boundaries, price erosion and generally intense competition. Certain wafer substrates, such as low quality wafer substrates for consumer products using LED lighting, compete almost entirely on price. Other products, such as InP and low EPD GaAs wafers, have fewer competitors and quality is a key competitive factor in addition to price. We face actual and potential competition from a number of established companies who have the advantage of greater name recognition and more established relationships in the industry. In some cases, our competitors have substantially greater financial, technical and marketing resources as they are divisions of much larger companies. They may utilize these advantages to expand their product offerings more quickly, adapt to new or emerging technologies and changes in customer requirements more quickly, and devote greater resources to the marketing and sale of their products. We believe a critical factor in

our business is technical support extended to the customer or prospective customer and we attempt to counter possible advantages of name recognition or size with superior technical support through the use of our team of technical sales support professionals, the majority of whom hold PhDs in physics or materials science.

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We believe that the primary competitive factors in the markets in which our substrate products compete are:

- quality;
- price;
- customer technical support;
- performance;
- meeting customer specifications; and
- manufacturing capacity.

Our ability to compete in target markets also depends on factors such as:

- the timing and success of the development and introduction of new products, including larger diameter wafers, and product features by us and our competitors;
- the availability of adequate sources of raw materials;
- protection of our proprietary methods, systems and process;
- protection of our products by effective use of intellectual property laws; and
- general economic conditions, which impact end markets using substrates.

A majority of our customers specialize in epitaxial growth, a complex series of chemical layers grown on top of our wafers. Typically, our customer or prospective customer has at least two qualified substrate suppliers. Qualified suppliers must meet industry standard specifications for quality, on-time delivery and customer support. Once a substrate supplier has qualified with a customer, price, consistent quality and current and future product delivery lead times become the most important competitive factors. A supplier that cannot meet a customer's current lead times or that a customer perceives will not be able to meet future demand and provide consistent quality can lose market share. Our primary competition in the market for compound and single element semiconductor substrates includes Sumitomo Electric Industries ("Sumitomo"), Japan Energy ("JX"), Freiburger Compound Materials ("Freiberger"), Umicore, and China Crystal Technology Corp. ("CCTC"). We believe that at least two of our competitors are shipping high volumes of GaAs substrates manufactured using a process similar to our VGF technology. In addition, we also face competition from semiconductor device manufacturers that may use other specialty material substrates that are not GaAs, InP or Ge based materials and that are actively exploring alternative materials. For example, silicon-on-insulator ("SOI") technology, a silicon wafer technology that produces satisfactory devices at lower cost, has been proven in the market. From 2012 to 2015, SOI technology displaced GaAs chips in key sectors, primarily the radio frequency (RF) switching function in cell phones.

Because of our vertically integrated, sophisticated supply chain through our subsidiaries and joint venture companies, we believe we are the only compound semiconductor substrate supplier to offer a broad suite of raw materials. We believe this gives us a unique competitive advantage because we have greater control and stability over many of our needed materials. Further, we believe we have some advantage in manufacturing costs. In the event of a significant increase in demand we believe our raw materials supply chain strategy and our ability to rapidly increase capacity can provide us some advantage.

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Intellectual Property

Our success and the competitive position of our VGF technology depend on our ability to maintain our proprietary process technology secrets and other intellectual property protections. We rely on a combination of patents, trademark and trade secret laws, non-disclosure agreements and other intellectual property protection methods to protect our proprietary technology. We believe that, due to the rapid pace of technological innovation in the markets for our products, our ability to establish and maintain a position of technology leadership depends as much on the skills of our research and development personnel as upon the legal protections afforded our existing technologies. To protect our trade secrets, we take certain measures to ensure their secrecy, such as executing non-disclosure agreements with our employees, customers and suppliers. However, reliance on trade secrets is only an effective business practice insofar as trade secrets remain undisclosed and a proprietary product or process is not reverse engineered or independently developed.

In addition to proprietary process trade secrets, we also file patents. To date, we have been issued 51 patents related to our VGF products and processes; 30 in China, nine in the United States, seven in Japan, two in Taiwan, one in the European Union, one in Canada and one in South Korea. Patents have a protected life of 20 years from their filing dates. Our patents have expiration dates ranging from one expiration in 2018 to 2035. In some cases we may consider filing divisional, continuation or continuation-in-part of the existing patents for additional claims. We have 15 patent applications pending, including 10 in China, three in the Patent Cooperation Treaty stage and two in Europe. We also have two provisional patents filed in 2018 in the United States. Furthermore, in aggregate, our three consolidated joint venture companies have been issued 53 patents in China, including 28 patents issued to Beijing BoYu Semiconductor Vessel Craftwork Technology Co. Ltd. (“BoYu”), 22 patents issued to Nanjing JinMei Gallium Co. Ltd. (“JinMei”) and 3 patents issued to Beijing JiYa Semiconductor material Co. Ltd. (“JiYa”).

We entered into a technology license and royalty agreement with Sumitomo, effective December 3, 2010, with a term of eight years, terminating December 31, 2018. We, and our related companies, were granted a worldwide, nonexclusive, royalty bearing, irrevocable license to certain patents for the term of the agreement. We are reviewing a request from Sumitomo to renew this license.

In the normal course of business, we periodically receive and make inquiries regarding possible patent infringement. In dealing with such inquiries, it may become necessary or useful for us to obtain or grant licenses or other rights. However, there can be no assurance that such licenses or rights will be available to us on commercially reasonable terms. If we are not able to resolve or settle claims, obtain necessary licenses on commercially reasonable terms and/or successfully prosecute or defend our position, our business, financial condition and results of operations could be materially and adversely affected.

Environmental Regulations

We are subject to federal, state and local environmental and safety laws and regulations in all of our operating locations, including laws and regulations of China, such as laws and regulations related to the development, manufacture and use of our products, the use of hazardous materials, the operation of our facilities, and the use of our real property. These laws and regulations govern the use, storage, discharge and disposal of hazardous materials during manufacturing, research and development and sales demonstrations. We maintain a number of environmental, health and safety programs that are primarily preventive in nature. As part of these programs, we regularly monitor ongoing compliance. If we fail to comply with applicable regulations, we could be subject to substantial liability for clean-up efforts, personal injury, fines or suspension or be forced to cease our operations, and/or suspend or terminate the development, manufacture or use of certain of our products, the use of our facilities, or the use of our real property, each of which could have a material adverse effect on our business, financial condition and results of operations. The regulatory landscape shifts and changes in China as that country attempts to address its

environmental pollution. Because we manufacture all of our products in China, we are subject to an evolving set of regulations that could require changes in our equipment and processes and require us to obtain new permits. In 2017, China increased its focus on environmental concerns which increased pressure on manufacturing companies. During periods of severe air pollution in Beijing, manufacturing companies, including AXT, may be ordered by the local government to stop production for several days.

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For example, in the first quarter of 2018, over 300 manufacturing companies, including AXT, were intermittently shut down by the local government for a total of ten days from February 27 to March 31, due to severe air pollution.

Employees

As of December 31, 2018, we had 781 employees, which consisted of 26 employees in our headquarters in Fremont, California, one sales professional in France and 754 employees in our factory in China. In addition, our three consolidated subsidiaries had, in total, 299 employees. In aggregate, we and our subsidiaries had 1,080 employees, of whom 886 were principally engaged in manufacturing, 141 in sales and administration and 53 in research and development. Of these 1,080 employees, 26 were located in the United States, one in France and 1,053 in China.

Most workers in China are represented by unions. As of December 31, 2018, 877 employees in China including employees of our subsidiaries were represented by unions. We have never experienced a work stoppage and we consider our relations with our employees to be good.

Geographical Information

Please see Note 14 of our Notes to Consolidated Financial Statements for information regarding our foreign operations, and see “Risks related to international aspects of our business” under Item 1A. Risk Factors for further information on risks attendant to our foreign operations and dependence.

Available Information

Our principal executive offices are located at 4281 Technology Drive, Fremont, CA 94538, and our main telephone number at this address is (510) 438-4700. Our Internet website address is www.axt.com. Our website address is given solely for informational purposes; we do not intend, by this reference, that our website should be deemed to be part of this Annual Report on Form 10-K or to incorporate the information available at our Internet address into this Annual Report on Form 10 K.

We file electronically with the Securities and Exchange Commission, or SEC, our annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K, and amendments to those reports filed or furnished pursuant to Section 13(a) or 15(d) of the Securities Exchange Act of 1934, as amended. We make these reports available free of charge through our Internet website as soon as reasonably practicable after we have electronically filed such material with the SEC. These reports can also be obtained from the SEC’s Internet website at www.sec.gov or at the SEC’s Public Reference Room at 100 F Street, N.E., Washington, D.C. 20549. The public may obtain information on the operation of the Public Reference Room by calling the SEC at 1-800-SEC-0330.

Item 1A. Risk Factors

For ease of reference, we have divided these risks and uncertainties into the following general categories:

- I. Risks related to our general business;
- II. Risks related to international aspects of our business;
- III. Risks related to our financial results and capital structure;
- IV. Risks related to our intellectual property; and
- V. Risks related to compliance, environmental regulations and other legal matters.

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I. Risks Related to Our General Business

Silicon substrates (wafers) are significantly lower in cost compared to substrates made from specialty materials, and new silicon-based technologies could enable silicon-based substrates to replace specialty material based substrates for certain applications.

Historically silicon wafers or substrates are less expensive than specialty material substrates, such as those that we produce. Electronic circuit designers will generally consider silicon first and only turn to alternative materials if silicon cannot provide the required functionality in terms of power consumption, speed, wave lengths or other specifications. Beginning in 2011, certain applications that had previously used GaAs substrates adopted a new silicon-based technology called silicon on insulator, or SOI. SOI technology uses a silicon-insulator-silicon layered substrate in place of conventional silicon substrates in semiconductor manufacturing. SOI substrates cost less than GaAs substrates and, although their performance is not as robust as GaAs substrates in terms of power consumption, heat generation and speed, they became acceptable in mobile phones and other applications that were previously dominated by GaAs substrates. The adoption of SOI resulted in decreased GaAs wafer demand, and decreased revenue. If SOI or new silicon-based technologies gain more widespread market acceptance, or are used in more applications, our sales of specialty material based substrates could be reduced and our business and operating results could be significantly and adversely affected.

Our gross margin has fluctuated historically and may decline due to several factors.

Our gross margin has fluctuated from period to period as a result of increases or decreases in total revenue, shifts in the cost of raw materials, shifts in product mix, costs related to the relocation of our gallium arsenide and germanium production lines, including costs related to the hiring additional manufacturing employees at our new locations, tariffs imposed by the U.S. government, the introduction of new products, decreases in average selling prices for products, utilization of our manufacturing capacity, fluctuations in manufacturing yields and our ability to reduce product costs. These factors and other variables change from period to period and these fluctuations are expected to continue in the future. A recent example is that in the third quarter of 2018 our gross margin was 37.1% but it dropped to 26.3% in fourth quarter of 2018 as a result of several of these factors.

In recent months, the prices of many of the raw materials that we use in our substrate manufacturing process have increased. Such price increases can increase our cost of revenue and reduce our gross margin.

Further, we do not control the prices at which our subsidiaries and other joint venture companies sell their raw material products to third parties and we do not control their production process. However, because we consolidate the results of three of these companies with our own, any reduction in their gross margins could have a significant, adverse impact on our overall gross margins. One or more of our companies has in the past sold, and may in the future sell, raw materials at significantly reduced prices in order to gain volume sales or sales to new customers. In addition, at some points in the last three years, the market price of gallium dropped below our per unit inventory cost and we incurred an inventory write down under the lower of cost or net realizable value accounting rules. In this regard, in the first quarter of 2018 our consolidated raw gallium company incurred a \$295,000 charge. In such events, our gross margin is adversely impacted.

Underutilizing our manufacturing facilities may result in declines in our gross margins.

An important factor in our success is the extent to which we are able to utilize the available capacity in our manufacturing facilities. A number of factors and circumstances may reduce utilization rates, including periods of industry overcapacity, low levels of customer orders, operating inefficiencies, mechanical failures and disruption of operations due to expansion, power interruptions, fire, flood, other natural disasters or calamities or

government-ordered mandatory factory shutdowns. Severe air pollution in Beijing can trigger mandatory factory shutdowns. For example, in the first quarter of 2018, over 300 manufacturing companies, including AXT, were intermittently shut down by the local government for a total of ten days from February 27 to March 31, due to severe air pollution. Further, we are increasing capacity by adding two new sites, which may reduce our utilization rate and increase our depreciation charges, at least until we de-commission part of our Beijing site. Because many portions of our manufacturing costs are relatively fixed,

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high utilization rates are critical to our gross margins and operating results. If we fail to achieve acceptable manufacturing volumes or experience product shipment delays, our results of operations will be negatively affected. During periods of decreased demand, we have underutilized our manufacturing lines. If we are unable to improve utilization levels at our facilities during periods of decreased demand and correctly manage capacity, the fixed expense levels will have an adverse effect on our business, financial condition and results of operations. For example, in the three months ended December 31, 2018, our revenue dropped to \$22.2 million and our gross margin was only 26.3%.

If we are unable to utilize the available capacity in or manufacturing facilities, we may need to implement a restructuring plan, which could have a material adverse effect on our revenue, our results of operations and our financial condition. For example, in 2013, we concluded that incoming orders were insufficient and that we were significantly underutilizing our factory capacity. As a result, in February 2014, we announced a restructuring plan with respect to our wholly-owned subsidiary, Beijing Tongmei Xtal Technology Co, Ltd., in order to better align manufacturing capacity with demand. Under the restructuring plan, we recorded a charge of approximately \$907,000 in the first quarter of 2014. In the second quarter of 2016, we restructured the operations of Beijing JiYa Semiconductor Material Co., Ltd., one of our partially owned consolidated subsidiaries, which resulted in a reduction in force of 28 positions that were no longer required to support production and operations.

If we receive fewer customer orders than forecasted or if our customers delay or cancel orders, we may not be able to reduce our manufacturing costs in the short-term and our gross margins would be negatively affected. In addition, lead times required by our customers are shrinking, which reduces our ability to forecast orders and properly balance our capacity utilization.

If we have low product yields, the shipment of our products may be delayed and our product cost and operating results may be adversely impacted.

A critical factor in our product cost is yield. Our products are manufactured using complex crystal growth and wafer processing technologies, and the number of usable wafer substrates we produce can fluctuate as a result of many factors, including:

- poor control of furnace temperature and pressure;
- impurities in the materials used;
- contamination of the manufacturing environment;
- quality control and inconsistency in quality levels;
- lack of automation and inconsistent processing requiring manual manufacturing steps;
- substrate breakage during the manufacturing process; and
- equipment failure, power outages or variations in the manufacturing process.

A current example where yield is of special concern is for our six-inch semi-conducting gallium arsenide substrates, which can be used for manufacturing opto-electronic devices in cell phones, enabling 3-D sensing. This application requires very low defect densities, also called etch pit densities, or EPD, and our yields will be lower than the yields achieved for the same substrate when it will be used in other applications. If we are unable to achieve the targeted quantity of low defect density substrates, then our manufacturing costs would increase and our gross margins would be negatively impacted.

In addition, we may modify our process to meet a customer specification, but this can impact our yields. If our yields decrease, our revenue could decline if we are unable to produce products to our customers' requirements. At the same time, our manufacturing costs could remain fixed, or could increase. Lower yields negatively impact our gross

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margin. We have experienced product shipment delays and difficulties in achieving acceptable yields on both new and older products, and delays and poor yields have adversely affected our operating results. We may experience similar problems in the future and we cannot predict when they may occur, their duration or severity.

If our manufacturing processes result in defects in our products making them unfit for use by our customers, our products would be rejected, resulting in compensation costs paid to our customers, and possible disqualification. This could lead to revenue loss and market share loss.

Risks exist in relocating our gallium arsenide manufacturing operations.

The Chinese government has imposed, and may impose in the future, manufacturing restrictions and regulations that require us to move part of our manufacturing operations to a different location or temporarily cease or limit manufacturing. Such relocation, or other restrictions on manufacturing, could materially and adversely impact our results of operations and our financial condition.

The Beijing city government is moving its offices into the area where our original manufacturing facility is currently located and is in the process of moving thousands of government employees into this area. The government has constructed showcase tower buildings and overseen the establishment of new apartment complexes, retail stores and restaurants. An amusement park is being constructed within a few miles of our facility. To create room and upgrade the district, the city instructed virtually all existing manufacturing companies, including AXT, to relocate all or some of their manufacturing lines. In 2018, we made significant progress in the relocation of our gallium arsenide and germanium production lines and we intend to complete this relocation in 2019.

The relocation of our gallium arsenide production line requires us to continue to accurately execute our relocation plan. A failure to properly complete our relocation could result in disruption to our production and have a material adverse impact on our revenue, our results of operations and our financial condition. We intend to secure additional permits and approvals in 2019. Given the fluidity and ever-increasing review of environmental and regulatory ordinances in China, there can be no assurance that these matters will be satisfactorily completed.

In 2018, we provided qualification wafers and our own internal characterization data from the new facilities to our customers. Our major customers are in the process of qualifying the wafer substrates before placing volume purchase orders for products from the new facilities. If we fail to meet the product qualification requirements of a customer, we may lose sales to that customer. Our reputation may also be damaged. Any loss of sales could have a material adverse effect on our revenue, our results of operations and our financial condition.

We expect many of the key employees who are employed at our current manufacturing facility to relocate to the new sites or commute under a program we are developing. There can be no assurances that the key employees will relocate. A loss of key employees or our inability to hire qualified employees could disrupt our production, which could materially and adversely impact our results of operations and our financial condition.

The Chinese government has in the past imposed temporary restrictions on manufacturing facilities, such as the restrictions imposed on polluting factories for the 2008 Olympics and the 2014 Asian Pacific Economic Cooperation event. These restrictions included a shutdown of the transportation of materials and power plants to reduce air pollution. To reduce air pollution in Beijing, the Chinese government has sometimes limited the construction of new, or expansion of existing, facilities by manufacturing companies in the Beijing area or required mandatory factory shutdowns. For example, in the first quarter of 2018, over 300 manufacturing companies, including AXT, were intermittently shut down by the local government for a total of ten days from February 27 to March 31 due to severe air pollution. If the government applies similar restrictions to us or requires mandatory factory shutdowns in the future, then such restrictions or shutdowns could have an adverse impact on our results of operations and our financial condition. Our ability to supply current or new orders could be significantly impacted. Customers could then be required to purchase products from our competitors, causing our competitors to take market share from us.

In addition, from time to time, the Chinese government issues new regulations, which may require additional actions on our part to comply. On February 27, 2015, the China State Administration of Work Safety updated its list of

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hazardous substances. The previous list, which was published in 2002, did not restrict the materials that we use in our wafers. The new list added gallium arsenide. As a result of the newly published list, we were instructed to obtain a permit to continue to manufacture our gallium arsenide substrate wafers. The Beijing municipal authority accepted our permit application in May 2015, but has not issued to us the requisite permit while we continue to execute our plan to relocate our gallium arsenide production. If our application is denied in the future before we complete our relocation, then our gallium arsenide production could be disrupted, which could materially and adversely impact our results of operations and our financial condition.

Customers may require that they re-qualify our gallium arsenide wafer substrates from the new manufacturing line.

As required by the Beijing city government we are relocating gallium arsenide production so that it is not within Beijing. In 2018, we provided qualification wafers and our own internal characterization data from the new facilities to our customers. Most of our major customers will view this as a process engineering change and their internal quality control system will require them to re-qualify the wafer substrates produced at our new manufacturing site to ensure that the product characteristics still conform to their specification. Delays in the qualification process or failures to re-qualify could result in a reduction of orders and have a material adverse effect on our revenue.

Global economic and political conditions, including trade tariffs and restrictions, have an impact on our business and financial condition in ways that we currently cannot predict.

Recent tariffs and threats of trade tariffs and restrictions between China and the United States may, in our view, create an unstable environment. In September 2018, the Trump Administration announced a list of thousands of categories of goods that are now subject to tariffs when imported into the United States. This pronouncement imposed 10% tariffs on our products and will have a negative impact on our operations and financial performance. Although we do not believe the initial impact of approximately \$150,000 per quarter is material, the future impact of tariffs and trade wars is uncertain.

Our operations and financial results depend on worldwide economic and political conditions and their impact on levels of business spending, which has deteriorated significantly in many countries and regions. Uncertainties in the political, financial and credit markets may cause our customers to postpone deliveries. Delays in the placement of new orders and extended uncertainties may reduce future sales of our products and services. The revenue growth and profitability of our business depends on the overall demand for our substrates, and we are particularly dependent on the market conditions in wireless, solid state illumination, fiber optics and telecommunications industries. Because the end users of our products are primarily large companies whose businesses fluctuate with general economic and business conditions, a softening of demand for products that use our substrates, caused by a weakening economy, may result in decreased revenue. Customers may find themselves facing excess inventory from earlier purchases, and may defer or reconsider purchasing products due to the downturn in their business and in the general economy. If market conditions deteriorate, we may experience increased collection times and greater write-offs, either of which could have a material adverse effect on our profitability and our cash flow.

Future tightening of credit markets and concerns regarding the availability of credit may make it more difficult for our customers to raise capital, whether debt or equity, to finance their purchases of capital equipment or of the products we sell. Delays in our customers' ability to obtain such financing, or the unavailability of such financing, would adversely affect our product sales and revenues and, therefore, harm our business and operating results. We cannot predict the timing, duration of or effect on our business of any future economic downturn or the timing or strength of any subsequent recovery.

If any of our facilities are damaged by occurrences such as fire, explosion, power outage or natural disaster, we might not be able to manufacture our products.

The ongoing operation of our manufacturing and production facilities in China is critical to our ability to meet demand for our products. If we are not able to use all or a significant portion of our facilities for prolonged periods for any reason, we would not be able to manufacture products for our customers. For example, a fire or explosion caused by our use of combustible chemicals, high furnace temperatures or, in the case of InP, high pressure during our

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manufacturing processes could render some or all of our facilities inoperable for an indefinite period of time. Actions outside of our control, such as earthquakes or other natural disasters, could also damage our facilities, rendering them inoperable. If we are unable to operate our facilities and manufacture our products, we would lose customers and revenue and our business would be harmed.

On the evening of March 15, 2017, an electrical short-circuit fire occurred at our Beijing manufacturing facility. The electrical power supply supporting 2-inch, 3-inch and 4-inch gallium arsenide and germanium crystal growth was damaged and production in that area was stopped. In addition, a waste water pipe was damaged resulting in a halt to wafer processing for four days until the pipe could be repaired. We were able to rotate key furnace hardware and use some of the 6-inch capacity for smaller diameter crystal growth production to mitigate the impact of the fire and resume production. If we are unable to recover from a fire or natural disaster, our business and operating results could be materially and adversely affected.

Demand for our products may decrease if demand for the end-user applications decrease or if manufacturers downstream in our supply chain experience difficulty manufacturing, marketing or selling their products.

Our products are used to produce components for electronic and opto-electronic products. Accordingly, demand for our products is subject to the demand for end-user applications which utilize our products, as well as factors affecting the ability of the manufacturers downstream in our supply chain to introduce and market their products successfully, including:

- worldwide economic and political conditions and their impact on levels of business spending;
- the competition such manufacturers face in their particular industries;
- the technical, manufacturing, sales, marketing and management capabilities of such manufacturers;
- the financial and other resources of such manufacturers; and
- the inability of such manufacturers to sell their products if they infringe third party intellectual property rights.

If demand for the end-user applications for which our products are used decreases, or if manufacturers downstream in our supply chain are unable to develop, market and sell their products, demand for our products will decrease. For example, in the fourth quarter of 2018, widespread political and economic instability and trade war concerns resulted in a general slowdown and our revenue decreased significantly. Additionally, in the second half of 2016, manufacturers producing and selling passive optical network devices known as EPONs and GPONs experienced a slowdown in demand resulting in surplus inventory on hand. The slowdown persisted until late in 2017. This resulted in a slowdown of sales of our InP substrates used in the PON market. We expect similar cycles of strong demand followed by lower demand will occur for various InP, GaAs or Ge substrates in the future.

Our revenue, gross margins and profitability can be hurt if the average sales price of the various raw materials in our partially owned companies decreases.

Although the companies in our vertically integrated supply chain have historically made a positive contribution to our financial performance, when the average selling prices for the raw materials produced decline, this results in a negative impact on our revenue, gross margin and profitability. For example, the average selling prices for 4N gallium and for germanium were driven down by oversupply in 2015, 2016 and 2017, and negatively impacted our financial results. In 2018, 2017 and 2016, the seven companies accounted for under the equity method of accounting contributed a loss of \$1.1 million, \$1.7 million and \$2.0 million, respectively, to our consolidated financial statements. There can be no assurance that the oversupply will be corrected by the market. Further, in several quarters over the past three years, one of our consolidated subsidiaries incurred a lower of cost or net realizable value inventory write down, which negatively impacted our consolidated gross margin. For example, in the first quarter of 2018, our

consolidated raw gallium company incurred an inventory write-down charge of \$295,000. In the first quarter of 2017, we incurred an

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impairment charge of \$313,000 against one of our partially owned companies, writing down our investment to zero value. If the pricing environment remains stressed by oversupply and our joint venture companies cannot reduce their production costs, then the reduced average selling prices of the raw materials produced by our joint venture companies will have a continuing adverse impact on our revenue, gross margins and net profit.

Problems incurred in our 10 partially owned joint venture companies or investment partners could result in a material adverse impact on our financial condition or results of operations.

We have invested in 10 partially owned subsidiaries and joint venture companies in China that produce materials, including 99.99% pure gallium (4N Ga), high purity gallium (7N Ga), arsenic, germanium, germanium dioxide, pyrolytic boron nitride (pBN) crucibles and boron oxide (B₂O₃). We purchase a portion of the materials produced by these companies for our use and they sell the remainder of their production to third parties. Our ownership and the ownership held by our consolidated subsidiaries in these companies range from 20% to 97%. We consolidate the companies in which we have a majority or controlling financial interest and employ equity accounting for the companies in which we have a smaller ownership interest. Several of these companies occupy space within larger facilities owned and/or operated by one of the other investment partners. Several of these partners are engaged in other manufacturing activities at or near the same facility. In some facilities, we share access to certain functions, including water, hazardous waste treatment or air quality treatment. If a partner in any of these ventures experiences problems with its operations, or deliberately withholds or disrupts services, disruptions in the operations of our companies could result, having a material adverse effect on the financial condition and results of operation in these companies, and correspondingly on our financial condition or results of operations. For example, since gallium is a by-product of aluminum, our raw gallium joint venture in China, which is housed in and receives services from an affiliated aluminum plant, could generate lower production and shipments of gallium as a result of reduced services provided by the aluminum plant. Accordingly, in order to meet customer supply obligations, our supply chain may have to source materials from another independent third party supplier, resulting in higher costs and reduced gross margin.

The China central government has become increasingly concerned about environmental hazards. Air pollution is a well-known problem in Beijing and other parts of China. In days of severe air pollution, the government has ordered manufacturing companies to stop all production. The central government is also tightening control over hazardous chemicals and other hazardous elements such as arsenic, which is produced by two of our unconsolidated joint venture companies. Regular use in the normal course of business of hazardous chemicals or hazardous elements or a company's failure to meet the ever tightening standards for control of hazardous chemicals or hazardous elements could result in orders to shut down permanently, fines or other severe measures. Any such orders directed at one of our joint venture companies could result in impairment charges if the company is forced to close its business, cease operations or incurs fines or operating losses, which would have a material adverse effect on our financial results.

Further, if any of our joint venture companies or investment partners with which our joint ventures share facilities is deemed to have violated applicable laws, rules or regulations governing the use, storage, discharge or disposal of hazardous chemicals, the operations of that joint venture could be adversely affected and we could be subject to substantial liability for clean-up efforts, personal injury, fines or suspension or termination of our joint venture's operations. Employees working for our joint ventures or any of the other investment partners could bring litigation against us as a result of actions taken at the joint venture or investment partner facilities, even though we are not directly controlling those operations. While we would expect to defend ourselves vigorously in any litigation that is brought against us, litigation is inherently uncertain and it is possible that our business, financial condition, results of operations or cash flows could be affected. Even if we are not deemed responsible for the actions of the joint ventures or investment partners, litigation could be costly, time consuming to defend and divert management attention; in addition, if we are deemed to be the most financially viable of the partners, plaintiffs may decide to pursue us for

damages.

Intense competition in the markets for our products could prevent us from increasing revenue and sustaining profitability.

The markets for our products are intensely competitive. We face competition for our substrate products from other manufacturers of substrates, such as Sumitomo, JX, Freiburger, Umicore, and CCTC, and from companies, such as Qorvo and Skyworks, that are actively considering alternative materials to GaAs and marketing semiconductor devices

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using these alternative materials. We believe that at least two of our major competitors are shipping high volumes of GaAs substrates manufactured using a process similar to our VGF process technology. Other competitors may develop and begin using similar technology. Sumitomo and JX also compete with us in the InP market. If we are unable to compete effectively, our revenue may decrease and we may not maintain profitability. We face many competitors that have a number of significant advantages over us, including:

- greater name recognition and market share in the business;
- more manufacturing experience;
- extensive intellectual property; and
- significantly greater financial, technical and marketing resources.

Our competitors could develop new or enhanced products that are more effective than our products.

The level and intensity of competition has increased over the past years and we expect competition to continue to increase in the future. Competitive pressures have resulted in reductions in the prices of our products, and continued or increased competition could reduce our market share, require us to further reduce the prices of our products, affect our ability to recover costs and result in reduced gross margins and profitability.

In addition, new competitors have and may continue to emerge, such as a crystal growing company established by a former employee in China that is supplying semi-conducting GaAs wafers to the LED market. Competition from sources such as this could increase, particularly if these competitors are able to obtain large capital investments.

Cyber-attacks, system security risks and data protection issues could disrupt our internal operations and cause a reduction in revenue, increase in expenses, negatively impact our results of operation or result in other adverse consequences.

Like most technology companies, we could be targeted in cyber-attacks. We face a risk that experienced computer programmers and hackers may be able to penetrate our network security and misappropriate or compromise our confidential and proprietary information, potentially without being detected. Computer programmers and hackers also may be able to develop and deploy viruses, worms, and other malicious software programs that attack our information technology infrastructure. The costs to us to eliminate or alleviate cyber or other security problems, bugs, viruses, worms, malicious software programs and security vulnerabilities could be significant, and our efforts to address these problems may not be successful and could result in interruptions and delays that may impede our sales, manufacturing, distribution, accounting or other critical functions.

Breaches of our security measures could create system disruptions or cause shutdowns or result in the accidental loss, inadvertent disclosure or unapproved dissemination of proprietary information or sensitive or confidential data about us. Cyber-attacks could use fraud, trickery or other forms of deception. A cyber-attack could expose us to a risk of loss or misuse of information, result in litigation and potential liability, damage our reputation or otherwise harm our business. In addition, the cost and operational consequences of implementing further data protection measures could be significant.

Portions of our information technology infrastructure might also experience interruptions, delays or cessations of service or produce errors in connection with systems integration or migration work that takes place from time to time, which may have a material impact on our business. We may not be successful in implementing new systems and transitioning data, which could cause business disruptions and be more expensive, time consuming, disruptive and resource-intensive than originally anticipated. Such disruptions could adversely impact our ability to fulfill orders and interrupt other processes. Delayed sales, lower margins or lost customers could adversely affect our financial results

and reputation.

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The average selling prices of our substrates may decline over relatively short periods, which may reduce our revenue and gross margins.

Since the market for our products is characterized by declining average selling prices resulting from various factors, such as increased competition, overcapacity, the introduction of new products and decreased sales of products incorporating our products, the average selling prices for our products may decline over relatively short time periods. We have in the past experienced, and in the future may experience, substantial period-to-period fluctuations in operating results due to declining average selling prices. In certain years, we have experienced an average selling price decline of our substrate selling prices of approximately 5% to 10%, depending on the substrate product. It is possible that the pace of the decline of average selling prices could accelerate beyond these levels for certain products in a commoditizing market. We anticipate that average selling prices will decrease in the future in response to the unstable demand environment, price reductions by competitors, or by other factors, including pricing pressures from significant customers. When our average selling prices decline, our revenue and gross profit decline, unless we are able to sell more products or reduce the cost to manufacture our products. We generally attempt to combat an average selling price decline by improving yields and manufacturing efficiencies and working to reduce the costs of our raw materials and of manufacturing our products. We also need to sell our current products in increasing volumes to offset any decline in their average selling prices, and introduce new products, which we may not be able to do, or do on a timely basis.

In order to remain competitive, we must continually work to reduce the cost of manufacturing our products and improve our yields and manufacturing efficiencies. Our efforts may not allow us to keep pace with competitive pricing pressures which could adversely affect our margins. There is no assurance that any changes effected by us will result in sufficient cost reductions to allow us to reduce the price of our products to remain competitive or improve our gross margins.

Defects in our products could diminish demand for our products.

Our wafer products are complex and may contain defects, including defects resulting from impurities inherent in our raw materials or inconsistencies in our manufacturing processes. We have experienced quality control problems with some of our products, which caused customers to return products to us, reduce orders for our products, or both. If we experience quality control problems, or experience other manufacturing problems, customers may return product for credit, cancel or reduce orders or purchase products from our competitors. We may be unable to maintain or increase sales to our customers and sales of our products could decline. Defects in our products could cause us to incur higher manufacturing costs and suffer product returns and additional service expenses, all of which could adversely impact our operating results. If new products developed by us contain defects when released, our customers may be dissatisfied and we may suffer negative publicity or customer claims against us, lose sales or experience delays in market acceptance of our new products.

Our substrate products have a long qualification cycle that makes it difficult to forecast revenue from new customers or for new products sold to existing customers.

New customers typically place orders with us for our substrate products three months to a year or more after our initial contact with them. The sale of our products is subject to our customers' lengthy internal evaluation and approval processes. During this time, we may incur substantial expenses and expend selling, marketing and management efforts while the customers evaluate our products. These expenditures may not result in sales of our products. If we do not achieve anticipated sales in a period as expected, we may experience an unplanned shortfall in our revenue. As a result, our operating results would be adversely affected. In addition, if we fail to meet the product qualification requirements of the customer, we may not have another opportunity to sell that product to that customer for many months or even years. In the current competitive climate, the average qualification and sales cycle for our products has

lengthened even further and is expected to continue to make it difficult for us to forecast our future sales accurately. We anticipate that sales of any future substrate products will also have lengthy qualification periods and will, therefore, be subject to risks substantially similar to those inherent in the lengthy sales cycles of our current substrate products.

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The loss of one or more of our key substrate customers would significantly hurt our operating results.

From time to time, sales to one or more of our customers individually represent more than 10% of our revenue and if we were to lose a major customer the loss would negatively impact our revenue. Most of our customers are not obligated to purchase a specified quantity of our products or to provide us with binding forecasts of product purchases. In addition, our customers may reduce, delay or cancel orders. In the past, we have experienced a slowdown in bookings, significant push-outs and cancellation of orders from customers. If we lose a major customer or if a customer cancels, reduces or delays orders, our revenue would decline. In addition, customers that have accounted for significant revenue in the past may not continue to generate revenue for us in any future period. Any loss of customers or any delay in scheduled shipments of our products could cause revenue to fall below our expectations and the expectations of market analysts or investors, causing our stock price to decline.

The cyclical nature of the semiconductor industry may limit our ability to maintain or increase net sales and operating results during industry downturns.

The semiconductor industry is highly cyclical and periodically experiences significant economic downturns characterized by diminished product demand, resulting in production overcapacity and excess inventory in the markets we serve. A downturn can result in lower unit volumes and rapid erosion of average selling prices. The semiconductor industry has experienced significant downturns, often in connection with, or in anticipation of, maturing product cycles of both semiconductor companies' and their customers' products or a decline in general economic conditions. This may adversely affect our results of operations and the value of our business.

Our continuing business depends in significant part upon manufacturers of electronic and opto-electronic compound semiconductor devices, as well as the current and anticipated market demand for these devices and products using these devices. As a supplier to the semiconductor industry, we are subject to the business cycles that characterize the industry. The timing, length and volatility of these cycles are difficult to predict. The compound semiconductor industry has historically been cyclical due to sudden changes in demand, the amount of manufacturing capacity and changes in the technology employed in compound semiconductors. The rate of changes in demand, including end demand, is high, and the effect of these changes upon us occurs quickly, exacerbating the volatility of these cycles. These changes have affected the timing and amounts of customers' purchases and investments in new technology. These industry cycles create pressure on our revenue, gross margin and net income.

Our industry has in the past experienced periods of oversupply and that has resulted in significantly reduced prices for compound semiconductor devices and components, including our products, both as a result of general economic changes and overcapacity. Oversupply causes greater price competition and can cause our revenue, gross margins and net income to decline. During periods of weak demand, customers typically reduce purchases, delay delivery of products and/or cancel orders for our products. Order cancellations, reductions in order size or delays in orders could occur and would materially adversely affect our business and results of operations. Actions to reduce our costs may be insufficient to align our structure with prevailing business conditions. We may be required to undertake additional cost-cutting measures, and may be unable to invest in marketing, research and development and engineering at the levels we believe are necessary to maintain our competitive position. Our failure to make these investments could seriously harm our business.

A significant portion of our operating expense and manufacturing costs are relatively fixed. If revenue for a particular quarter is lower than we expect, we likely will be unable to proportionately reduce our operating expenses or fixed manufacturing costs for that quarter, which would harm our operating results.

If we do not successfully develop new product features and improvements and new products that respond to customer requirements, our ability to generate revenue, obtain new customers, and retain existing customers may suffer.

Our success depends on our ability to offer new product features, improved performance characteristics and new products, such as larger diameter substrates, low defect density substrates, thicker or thinner substrates, substrates with extreme surface flatness specifications, substrates that are manufactured with a doped crystal growth process or substrates that incorporate leading technology and other technological advances. New products must meet customer

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needs and compete effectively on quality, price and performance. The markets for our products are characterized by rapid technological change, changing customer needs and evolving industry standards. If our competitors introduce products employing new technologies or performance characteristics, our existing products could become obsolete and unmarketable. Over time, we have seen our competitors selling more substrates manufactured using a crystal growth technology similar to ours, which has eroded our technological differentiation.

The development of new product features, improved performance characteristics and new products can be a highly complex process, and we may experience delays in developing and introducing them. Any significant delay could cause us to fail to timely introduce and gain market acceptance of new products. Further, the costs involved in researching, developing and engineering new products could be greater than anticipated. If we fail to offer new products or product enhancements or fail to achieve higher quality products, we may not generate sufficient revenue to offset our development costs and other expenses or meet our customers' requirements.

We have made and may continue to make strategic investments in raw materials suppliers, which may not be successful and may result in the loss of all or part of our investment.

We have made direct investments or investments through our subsidiaries in 10 raw material suppliers in China, which provide us with opportunities to gain supplies of key raw materials that are important to our substrate business. These affiliates each have a market beyond that provided by us. We do not have significant influence over every one of these companies and in some we have made only a strategic, minority investment. We may not be successful in achieving the financial, technological or commercial advantage upon which any given investment is premised, and we could end up losing all or part of our investment which would have a negative impact on our results of operations. In the first quarter of 2017, we incurred an impairment charge of \$313,000 against one of our partially owned suppliers, writing down our investment to zero value. The significant decline in the selling prices of raw materials which began in 2015 and continued through 2017 has weakened some of these companies and their losses have negatively impacted our financial results. Further, the increasing concern and restrictions in China of hazardous chemicals and other hazardous elements could result in orders to shut down permanently, fines or other severe measures. Any such orders directed at one of our joint venture companies could result in impairment charges if the company is forced to close its business, cease operations or incurs fines, or operating losses, which would have a material adverse effect on our financial results.

We purchase critical raw materials and parts for our equipment from single or limited sources, and could lose sales if these sources fail to fill our needs.

We depend on a limited number of suppliers for certain raw materials, components and equipment used in manufacturing our products, including key materials such as quartz tubing, and polishing solutions. We generally purchase these materials through standard purchase orders and not pursuant to long-term supply contracts, and no supplier guarantees supply of raw materials or equipment to us. If we lose any of our key suppliers, our manufacturing efforts could be significantly hampered and we could be prevented from timely producing and delivering products to our customers. Prior to investing in our subsidiaries and joint ventures, we sometimes experienced delays obtaining critical raw materials and spare parts, including gallium, and we could experience such delays again in the future due to shortages of materials or for other reasons. Delays in receiving equipment or materials could result in higher costs and cause us to delay or reduce production of our products. If we have to delay or reduce production, we could fail to meet customer delivery schedules and our revenue and operating results could suffer.

We may not be able to identify or form additional complementary joint ventures.

We might invest in additional joint venture companies in order to remain competitive in our marketplace and ensure a supply of critical raw materials. However, we may not be able to identify additional complementary joint venture

opportunities or, even once opportunities are identified, we may not be able to reach agreement on the terms of the business venture with the other investment partners. Further, geopolitical tensions and trade wars could result in government agencies blocking such new joint ventures. New joint ventures could require cash investments or cause us to incur additional liabilities or other expenses, any of which could adversely affect our financial condition and operating results.

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The financial condition of our customers may affect their ability to pay amounts owed to us.

Some of our customers may be undercapitalized and cope with cash flow issues. Because of competitive market conditions, we may grant our customers extended payment terms when selling products to them. Subsequent to our fulfilling an order, some customers have been unable to make payments when due, reducing our cash balances and causing us to incur charges to allow for a possibility that some accounts might not be paid. We have had some customers file for bankruptcy. If our customers do not pay amounts owed to us then we will incur charges that would reduce our earnings.

We depend on the continuing efforts of our senior management team and other key personnel. If we lose members of our senior management team or other key personnel, or are unable to successfully recruit and train qualified personnel, our ability to manufacture and sell our products could be harmed.

Our future success depends on the continuing services of members of our senior management team and other key personnel. Our industry is characterized by high demand and intense competition for talent, and the turnover rate can be high. We compete for qualified management and other personnel with other specialty material companies and semiconductor companies. Our employees could leave our company with little or no prior notice and would be free to work for a competitor. If one or more of our senior executives or other key personnel were unable or unwilling to continue in their present positions, we may not be able to replace them easily or at all, and other senior management may be required to divert attention from other aspects of the business. The loss of any of these individuals or our ability to attract or retain qualified personnel could adversely affect our business.

Our results of operations may suffer if we do not effectively manage our inventory.

We must manage our inventory of raw materials, work in process and finished goods effectively to meet changing customer requirements, while keeping inventory costs down and improving gross margins. Although we seek to maintain sufficient inventory levels of certain materials to guard against interruptions in supply and to meet our near term needs, we may experience shortages of certain key materials. Some of our products and supplies have in the past and may in the future become obsolete while in inventory due to changing customer specifications, or become excess inventory due to decreased demand for our products and an inability to sell the inventory within a foreseeable period. This would result in charges that reduce our gross profit and gross margin. Furthermore, if market prices drop below the prices at which we value inventory, we would need to take a charge for a reduction in inventory values in accordance with the lower of cost or net realizable value valuation rule. We have in the past had to take inventory valuation and impairment charges. Any future unexpected changes in demand or increases in costs of production that cause us to take additional charges for un-saleable, obsolete or excess inventory, or to reduce inventory values, would adversely affect our results of operations.

Financial market volatility and adverse changes in the domestic, global, political and economic environment could have a significant adverse impact on our business, financial condition and operating results.

We are subject to the risks arising from adverse changes and uncertainty in domestic and global economies. Uncertain global economic and political conditions or low or negative growth in China, Europe or the United States, along with volatility in the financial markets, increasing national debt and fiscal concerns in various regions, pose challenges to our industry. Currently China's economy is slowing and this could impact our financial performance. In addition, tariffs, trade restrictions, trade wars and Brexit are creating an unstable environment and can disrupt or restrict commerce. Although we remain well-capitalized, the cost and availability of funds may be adversely affected by illiquid credit markets. Turbulence in U.S. and international markets and economies may adversely affect our liquidity, financial condition and profitability. Another severe or prolonged economic downturn could result in a variety of risks to our business, including:

- increased volatility in our stock price;
- increased volatility in foreign currency exchange rates;

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- delays in, or curtailment of, purchasing decisions by our customers or potential customers;
 - increased credit risk associated with our customers or potential customers, particularly those that may operate in industries most affected by the economic downturn; and
- impairment of our tangible or intangible assets.

In the past we experienced delays in customer purchasing decisions and disruptions in normal volume of customer orders that we believe were in part due to the uncertainties in the global economy and an adverse impact on consumer spending. During challenging and uncertain economic times and in tight credit markets, many customers delay or reduce technology purchases. Should similar events occur again, our business and operating results could be significantly and adversely affected.

The effect of terrorist threats and actions on the general economy could decrease our revenue.

Countries such as the United States and China continue to be on alert for terrorist activity. The potential near and long-term impact terrorist activities may have in regards to our suppliers, customers and markets for our products and the economy is uncertain. There may be embargos of ports or products, or destruction of shipments or our facilities, or attacks that affect our personnel. There may be other potentially adverse effects on our operating results due to significant events that we cannot foresee. Since we perform all of our manufacturing operations in China, terrorist activity or threats against U.S. owned enterprises are a particular concern to us.

II. Risks Related to International Aspects of Our Business

The Chinese central government is increasingly aware of air pollution and other forms of environmental pollution and their reform efforts can impact our manufacturing, including intermittent mandatory shutdowns.

The Chinese central government is demonstrating strong leadership to improve air quality and reduce environmental pollution. These efforts have impacted manufacturing companies through mandatory shutdowns, increased inspections and regulatory reforms. In the fourth quarter of 2017, many manufacturing companies in the greater Beijing area, including AXT, were instructed by the local government to cease most manufacturing for several days until the air quality improved. In the first quarter of 2018, from February 27 to March 31 over 300 manufacturing companies were again intermittently shut down by the local government for a total of ten days, or 30 percent of the remaining calendar days, due to severe air pollution. Our shipments were delayed and our revenue for the quarter was negatively impacted. We expect that mandatory factory shutdowns will occur in the future. If the frequency of such shutdowns increases, especially at the end of a quarter, or if the total number of days of shutdowns prevents us from producing enough wafers to ship, then these shutdowns will have a material adverse effect on our manufacturing output, revenue and factory utilization. We are currently relocating our gallium arsenide and germanium manufacturing and are adding capacity at our new sites. We believe these efforts will mitigate our exposure to mandatory factory shutdowns. However, until the majority of our relocation is completed and our new facilities are in volume production, there is no mitigation of the risk of mandatory factory shutdowns. Each of our ten raw material supply chain companies could also be impacted by environmental related orders from the central government.

Enhanced trade tariffs, import restrictions, export restrictions, Chinese regulations or other trade barriers may materially harm our business.

All of our wafer substrates are manufactured in China and in 2018, approximately 10% of our revenue was generated by sales to customers in North America, primarily in the U.S. In September 2018, the Trump Administration announced a list of thousands of categories of goods that will face tariffs of 10%. Our inbound products to the U.S. are subject to a 10% tariff assessed on the customs value of the goods as imported by us, effective approximately September 24, 2018. Although we do not believe the initial impact of approximately \$150,000 per quarter is material, the future impact of tariffs and trade wars is uncertain. The tariffs could be increased to 25% in the future. We may be required to raise prices, which may result in the loss of customers and our business, financial condition and results of operations

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may be materially harmed. Additionally, the Trump Administration continues to signal that it may alter trade agreements and terms between China and the United States, including limiting trade with China, and may impose additional tariffs on imports from China. It is possible that our business could be adversely impacted by retaliatory trade measures taken by China or other countries in response to existing or future tariffs, which could cause us to raise prices or make changes to our operations, which could materially harm our business, financial condition and results of operations. Further, the continued threats of tariffs and other trade restrictions could have a generally disruptive impact on the global economy and, therefore, negatively impact our sales.

In addition, we may incur increases in costs and other adverse business consequences, including loss of revenue or decreased gross margins, due to changes in tariffs, import or export restrictions, further trade barriers, or unexpected changes in regulatory requirements. For example, in July 2012, we received notice of retroactive value-added taxes (VATs) levied by the tax authorities in China, which applied for the period from July 1, 2011 to June 30, 2012. We expensed the retroactive VATs of approximately \$1.3 million in the quarter ended June 30, 2012, which resulted in a decrease in our gross margins. These VATs will continue to negatively impact our gross margins for the future quarters. Given the relatively fluid regulatory environment in China and the United States, there could be additional tax or other regulatory changes in the future. Any such changes could directly and materially adversely impact our financial results and general business condition.

We derive a significant portion of our revenue from international sales, and our ability to sustain and increase our international sales involves significant risks.

Approximately 90% of our revenue is from international sales. We expect that sales to customers outside the United States, particularly sales to customers in Japan, Taiwan and China, will continue to represent a significant portion of our revenue. Therefore, our revenue growth depends significantly on the expansion of our international sales and operations.

All of our manufacturing facilities and most of our suppliers are also located outside the United States. Managing our overseas operations presents challenges, including periodic regional economic downturns, trade balance issues, threats of trade wars, varying business conditions and demands, political instability, variations in enforcement of intellectual property and contract rights in different jurisdictions, differences in the ability to develop relationships with suppliers and other local businesses, changes in U.S. and international laws and regulations, including U.S. export restrictions, fluctuations in interest and currency exchange rates, the ability to provide sufficient levels of technical support in different locations, cultural differences and perceptions of U.S. companies, shipping delays and terrorist acts or acts of war, among other risks. Many of these challenges are present in China, which represents a large potential market for semiconductor devices. Global uncertainties with respect to: (i) economic growth rates in various countries; (ii) sustainability of demand for electronic products; (iii) capital spending by semiconductor manufacturers; (iv) price weakness for certain semiconductor devices; (v) changing and tightening environmental regulations; (vi) political instability in regions where we have operations and (vii) trade wars may also affect our business, financial condition and results of operations.

Our dependence on international sales involves a number of risks, including:

- changes in tariffs, import restrictions, export restrictions, or other trade barriers;
- unexpected changes in regulatory requirements;
- longer periods to collect accounts receivable;

- foreign exchange rate fluctuations;
- changes in export license requirements;
- political and economic instability; and

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- unexpected changes in diplomatic and trade relationships.

Most of our sales are denominated in U.S. dollars, except for sales to our Chinese customers which are denominated in renminbi and our Japanese customers which are denominated in Japanese yen. We also have some small sales denominated in Euro. Increases in the value of the U.S. dollar could increase the price of our products in non-U.S. markets and make our products more expensive than competitors' products in these markets.

We are subject to foreign exchange gains and losses that materially impact our income statement.

We are subject to foreign exchange gains and losses that materially impact our statement of operations. For example, in 2017 we incurred a loss of \$602,000.

The functional currency of our wholly owned Chinese subsidiary and our partially owned joint venture companies is the Chinese renminbi, the local currency. We can incur foreign exchange gains or losses when we pay dollars to one of our China-based companies or a third party supplier in China. Similarly, if a company in China pays renminbi into one of our bank accounts transacting in dollars the renminbi will be converted to dollars and we can incur a foreign exchange gain or loss. Hedging renminbi will be considered in the future but it is complicated by the number of companies involved, the diversity of transactions and restrictions imposed by the banking system in China.

Sales to Japanese customers are denominated in Japanese yen. This subjects us to fluctuations in the exchange rates between the U.S. dollar and the Japanese yen and can result in foreign exchange gains and losses. This has been problematic in the past and, therefore, we instituted a foreign currency hedging program dealing with yen which has mitigated the problem.

Joint venture companies in China bring certain risks.

Since our wholly owned subsidiaries and all of our partially owned companies reside in China, their activities could subject us to a number of risks associated with conducting operations internationally, including:

- unexpected changes in regulatory requirements that may limit our ability to manufacture, export the products of these companies or sell into particular jurisdictions or impose multiple conflicting tax laws and regulations;
- the imposition of tariffs, trade barriers and duties;
- difficulties in managing geographically disparate operations;
 - difficulties in enforcing agreements through non-U.S. legal systems;
- political and economic instability, civil unrest or war;
- terrorist activities that impact international commerce;
- difficulties in protecting our intellectual property rights, particularly in countries where the laws and practices do not protect proprietary rights to as great an extent as do the laws and practices of the United States;
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- changing laws and policies affecting economic liberalization, foreign investment, currency convertibility or exchange rates, taxation or employment; and
- nationalization of foreign owned assets, including intellectual property.

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Uncertainty regarding the United States' foreign policy under the current administration could disrupt our business.

We manufacture our substrates in China and, in 2018, approximately 90% of our sales were to customers located outside of the United States. Further, we have partial ownership of 10 companies in China as part of our supply chain. The United States' current foreign policy could create uncertainty and caution in the international business community, resulting in possible disruptions in manufacturing, import/export, trade tariffs, sales, investments or other business activity. Such disruptions could have an adverse impact on our financial performance.

If China places restrictions on freight and transportation routes and on port of entry and departure this could result in shipping delays or increased costs for shipping.

In August 2015, there was an explosion at the Port of Tianjin, China. As a result of this incident the government placed restrictions on importing certain materials and on freight routes used to transport these materials. We experienced some modest disruption from these restrictions. If the government were to place additional restrictions on the transportation of materials, then our ability to transport our raw materials or products could be limited and result in manufacturing delays or bottlenecks at shipping ports, affecting our ability to deliver products to our customers. During periods of such restrictions, we may increase our stock of critical materials (such as arsenic, gallium, and other chemicals) for use during the period that these restrictions are likely to last, which will increase our use of cash and increase our inventory level. Any of these restrictions could materially and adversely impact our results of operations and our financial condition.

Our operating results depend in large part on continued customer acceptance of our substrate products manufactured in China and continued improvements in product quality.

We manufacture all of our products in China, and source most of our raw materials in China. We have in the past experienced quality problems with our China manufactured products. Our previous quality problems caused us to lose market share to our competitors, as some of our customers reduced their orders until our wafer surface quality was as good and as consistent as that offered by our competitors and instead allocated their requirements for compound semiconductor substrates to our competitors. If we are unable to continue to achieve customer qualifications for our products, or if we are unable to control product quality, customers may not increase purchases of our products, our China facilities will become underutilized, and we will be unable to achieve revenue growth.

Changes in China's political, social, regulatory or economic environments may affect our financial performance.

Our financial performance may be affected by changes in China's political, social, regulatory or economic environments. The role of the Chinese central and local governments in the Chinese economy is significant. Chinese policies toward hazardous materials, including arsenic, environmental controls, air pollution, economic liberalization, laws and policies affecting technology companies, foreign investment, currency exchange rates, taxation structure and other matters could change, resulting in greater restrictions on our ability to do business and operate our manufacturing facilities in China. We have observed a growing fluidity and tightening of regulations concerning hazardous materials, other environmental controls and air pollution. The Chinese government could revoke, terminate

or suspend our operating licenses for reasons related to environmental control over the use of hazardous materials, air pollution, labor complaints, national security and similar reasons without compensation to us. In days of severe air pollution the government has ordered manufacturing companies to stop all production. For example, in the fourth quarter of 2017 many manufacturing companies in the greater Beijing area, including AXT, were instructed by the local government to cease most manufacturing for several days until the air quality improved. In the first quarter of 2018, from February 27 to March 31 over 300 manufacturing companies, including us, were again intermittently shut down by the local government for a total of ten days due to severe air pollution. Our shipments were delayed and our revenue for the quarter was negatively impacted. We expect that mandatory factory shutdowns will occur in the future. Any failure on our part to comply with governmental regulations could result in the loss of our ability to manufacture our products. Further, any imposition of surcharges or any increase in Chinese tax rates or reduction or elimination of Chinese tax benefits could hurt our financial results.

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An important example of some of these factors is seen in a change underway in Beijing. The Beijing city government is moving its offices into the area where our original manufacturing facility is currently located and is in the process of moving thousands of government employees into this area. To create room and upgrade the district, the city instructed virtually all existing manufacturing companies, including AXT, to relocate all or some of their manufacturing lines. In 2018, AXT made significant progress in the relocation of our gallium arsenide and germanium production lines and we intend to complete this relocation in 2019.

The relocation of our gallium arsenide production line requires us to continue to accurately execute our relocation plan. A failure to properly complete our relocation could result in disruption to our production and have a material adverse impact on our revenue, our results of operations and our financial condition. We intend to secure additional permits and approvals in 2019. Given the fluidity and ever-increasing review of environmental and regulatory ordinances in China, there can be no assurance that these matters will be satisfactorily completed.

Further, our major customers are in the process of qualifying the wafer substrates from the new sites before placing volume purchase orders for products from the new facilities. If we fail to meet the product qualification requirements of a customer, we may lose sales to that customer. Our reputation may also be damaged. Any loss of sales could have a material adverse effect on our revenue, our results of operations and our financial condition.

Our international operations are exposed to potential adverse tax consequence in China.

Our international operations create a risk of potential adverse tax consequences. Taxes on income in our China-based companies are dependent upon acceptance of our operational practices and intercompany transfer pricing by local tax authorities as being on an arm's length basis. Due to inconsistencies among taxing authorities in application of the arm's length standard, transfer pricing challenges by tax authorities could, if successful, materially increase our consolidated income tax expense. We are subject to tax audits in China and an audit could result in the assessment of additional income tax against us. This could have a material adverse effect on our operating results or cash flows in the period or periods for which that determination is made and could result in increases to our overall tax expense in subsequent periods. Various taxing agencies in China are increasingly focused on tax reform and other legislative action to increase tax revenue. In addition to risks regarding income tax we have in the past been retroactively assessed value added taxes ("VAT" or sales tax) and such VAT assessments could occur again in the future.

If there are power shortages in China, we may have to temporarily close our China operations, which would adversely impact our ability to manufacture our products and meet customer orders, and would result in reduced revenue.

In the past, China has faced power shortages resulting in power demand outstripping supply in peak periods. Instability in electrical supply has caused sporadic outages among residential and commercial consumers causing the Chinese government to implement tough measures to ease the energy shortage. If further problems with power shortages occur in the future, we may be required to make temporary closures of our operations or of our subsidiary and joint venture operations. We may be unable to manufacture our products and would then be unable to meet customer orders except from finished goods inventory on hand. As a result, our revenue could be adversely impacted, and our relationships with our customers could suffer, impacting our ability to generate future revenue. In addition, if

power is shut off at any of our facilities at any time, either voluntarily or as a result of unplanned brownouts, during certain phases of our manufacturing process including our crystal growth phase, the work in process may be ruined and rendered unusable, causing us to incur costs that will not be covered by revenue, and negatively impacting our cost of revenue and gross margins.

An outbreak of a contagious disease such as Ebola, Severe Acute Respiratory Syndrome (SARS) or the Avian Flu may adversely impact our manufacturing operations and some of our key suppliers and customers.

Any reoccurrence of SARS or an outbreak of a contagious disease, such as Avian Flu or Ebola, may cause us to temporarily close our manufacturing operations. Similarly, if one or more of our key suppliers is required to close for an extended period, we might not have enough raw material inventories to continue manufacturing operations. In addition,

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while we possess management skills among our China staff that enable us to maintain our manufacturing operations with minimal on-site supervision from our U.S. based staff, our business could also be harmed if travel to or from China and the United States is restricted or inadvisable. If our manufacturing operations were closed for a significant period, we could lose revenue and market share, which would depress our financial performance and could be difficult to recapture. Finally, if one of our key customers is required to close for an extended period, we might not be able to ship product to them, our revenue would decline and our financial performance would suffer.

III. Risks Related to Our Financial Results and Capital Structure

We may utilize our cash balances for relocation, expansion, or to offset a business downturn resulting in the decline of our existing cash, cash equivalents and investment balances, and if we need additional capital, those funds may not be available on acceptable terms, or at all.

Our liquidity is affected by many factors including, among others, the relocation of our gallium arsenide manufacturing operations, the extent to which we pursue on-going capital expenditures, the acquisition and build out of the sites at Dingxing and Kazuo, the level of our production, the level of profits or losses, and other factors related to the uncertainties of the industry and global economies. Our relocation expenditures and any negative cash flow effects of these other factors will draw down our cash reserves, which could adversely affect our financial condition, reduce our value and possibly impinge our ability to raise debt and equity funding in the future, at a time when we might need to raise additional cash or elect to raise additional cash. Accordingly, there can be no assurance that events will not require us to seek additional capital or, if required, that such capital would be available on terms acceptable to us, if at all.

Unpredictable fluctuations in our operating results could disappoint analysts or our investors, which could cause our stock price to decline.

We have experienced, and may continue to experience, significant fluctuations in our revenue, gross margins and earnings. Our quarterly and annual revenue and operating results have varied significantly in the past and may vary significantly in the future due to a number of factors, including:

- our ability to develop, manufacture and deliver high quality products in a timely and cost-effective manner;
- disruptions during the relocation of our gallium arsenide product line;
- disruptions in manufacturing if air pollution or another environmental hazard causes the government to order work stoppages;
- fluctuation of our manufacturing yields;
- decreases in the prices of our or our competitors' products;
- fluctuations in demand for our products;
- the volume and timing of orders from our customers, and cancellations, push-outs and delays of customer orders once booked;
 - decline in general economic conditions or downturns in the industry in which we compete;
- expansion of our manufacturing capacity;
- expansion of our operations in China;
- limited availability and increased cost of raw materials;

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- costs incurred in connection with any future acquisitions of businesses or technologies; and
- increases in our expenses, including expenses for research and development.

Due to these factors, we believe that period-to-period comparisons of our operating results may not be meaningful indicators of our future performance.

A substantial percentage of our operating expenses are fixed, and we may be unable to adjust spending to compensate for an unexpected shortfall in revenue. As a result, any delay in generating revenue could cause our operating results to fall below the expectations of market analysts or investors, which could also cause our stock price to decline.

If our operating results and financial performance do not meet the guidance that we have provided to the public, our stock price may decline.

We provide public guidance on our expected operating and financial results. Although we believe that this guidance provides our stockholders, investors and analysts with a better understanding of our expectations for the future, such guidance is comprised of forward-looking statements subject to the risks and uncertainties described in this report and in our other public filings and public statements. Our actual results may not meet the guidance we have provided. If our operating or financial results do not meet our guidance or the expectations of investment analysts, our stock price may decline.

We have adopted certain anti-takeover measures that may make it more difficult for a third party to acquire us.

Our board of directors has the authority to issue up to 800,000 shares of preferred stock in addition to the outstanding shares of Series A preferred stock and to determine the price, rights, preferences and privileges of those shares without any further vote or action by the stockholders. The rights of the holders of common stock will be subject to, and may be adversely affected by, the rights of the holders of any preferred stock that may be issued in the future. The issuance of shares of preferred stock could have the effect of making it more difficult for a third party to acquire a majority of our outstanding voting stock. We have no present intention to issue additional shares of preferred stock.

Provisions in our restated certificate of incorporation and amended and restated bylaws may have the effect of delaying or preventing a merger, acquisition or change of control, or changes in our management, which could adversely affect the market price of our common stock. The following are some examples of these provisions:

- the division of our board of directors into three separate classes, each with three-year terms;
- the right of our board to elect a director to fill a space created by a board vacancy or the expansion of the board;
- the ability of our board to alter our amended and restated bylaws; and
- the requirement that only our board or the holders of at least 10% of our outstanding shares may call a special meeting of our stockholders.

Furthermore, because we are incorporated in Delaware, we are subject to the provisions of Section 203 of the Delaware General Corporation Law. These provisions prohibit us from engaging in any business combination with any interested stockholder (a stockholder who owns 15% or more of our outstanding voting stock) for a period of three years following the time that such stockholder became an interested stockholder, unless:

- 66 $\frac{2}{3}$ % of the shares of voting stock not owned by the interested stockholder approve the merger or combination, or

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· the board of directors approves the merger or combination or the transaction which resulted in the stockholder becoming an interested stockholder.

Our common stock may be delisted from The Nasdaq Global Select Market, which could negatively impact the price of our common stock and our ability to access the capital markets.

Our common stock is listed on The Nasdaq Global Select Market. The bid price of our common stock has in the past closed below the \$1.00 minimum per share bid price required for continued inclusion on The Nasdaq Global Select Market under Marketplace Rule 5450(a). If the bid price of our common stock remains below \$1.00 per share for thirty consecutive business days, we could be subject to delisting from the Nasdaq Global Select Market.

Any delisting from The Nasdaq Global Select Market could have an adverse effect on our business and on the trading of our common stock. If a delisting of our common stock were to occur, our common stock would trade in the over-the-counter market and be quoted on a service such as those provided by OTC Markets Group, Inc. Such alternatives are generally considered to be less efficient markets, and our stock price, as well as the liquidity of our common stock, may be adversely impacted as a result. Delisting from The Nasdaq Global Select Market could also have other negative results, including the potential loss of confidence by customers, suppliers and employees, the loss of institutional investor interest and fewer business development opportunities, as well as the loss of liquidity for our stockholders.

Our ability to use our net operating loss carryforwards and certain other tax attributes may be limited.

As of December 31, 2018, we had U.S. federal net operating loss carryforwards of approximately \$64.3 million and state net operating loss carryforwards of approximately \$0.3 million, which begin expiring in varying amounts from 2022 if unused. Under Sections 382 and 383 of the Internal Revenue Code of 1986, as amended, if a corporation undergoes an “ownership change,” the corporation’s ability to use its pre-change net operating loss carryforwards and other pre-change tax attributes, such as research tax credits, to offset its post-change income and taxes may be limited. In general, an “ownership change” occurs if there is a cumulative change in our ownership by “5% shareholders” that exceeds 50 percentage points over a rolling three-year period. Similar rules may apply under state tax laws. We might have undergone prior ownership changes, and we may undergo ownership changes in the future, which may result in limitations on our net operating loss carryforwards and other tax attributes. Any such limitations on our ability to use our net operating loss carryforwards and other tax attributes could adversely impact our business, financial condition and results of operations.

IV. Risks Related to Our Intellectual Property

Intellectual property infringement claims may be costly to resolve and could divert management attention.

Other companies may hold or obtain patents on inventions or may otherwise claim proprietary rights to technology necessary to our business. The markets in which we compete are comprised of competitors that in some cases hold substantial patent portfolios covering aspects of products that could be similar to ours. We could become subject to claims that we are infringing patent, trademark, copyright or other proprietary rights of others. We have in the past been involved in lawsuits alleging patent infringement, and could in the future be involved in similar litigation. For example, we entered into a settlement agreement with Sumitomo in 2011 to settle its claim of patent infringement, which resulted in AXT paying them royalties.

If we are unable to protect our intellectual property, including our non-patented proprietary process technology, we may lose valuable assets or incur costly litigation.

We rely on a combination of patents, copyrights, trademarks, trade secrets and trade secret laws, non-disclosure agreements and other intellectual property protection methods to protect our proprietary technology. We believe that our internal, non-patented proprietary process technology methods, systems and processes are a valuable and critical element of our intellectual property. We must establish and maintain safeguards to avoid the theft of these processes. Our ability to establish and maintain a position of technology leadership also depends on the skills of our development personnel.

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Despite our efforts to protect our intellectual property, third parties can develop products or processes similar to ours. Our means of protecting our proprietary rights may not be adequate, and our competitors may independently develop similar technology, duplicate our products or design around our patents. We believe that at least two of our competitors ship GaAs substrates produced using a process similar to our VGF process. Our competitors may also develop and patent improvements to the VGF technology upon which we rely, and thus may limit any exclusivity we enjoy by virtue of our patents or trade secrets.

It is possible that pending or future United States or foreign patent applications made by us will not be approved, that our issued patents will not protect our intellectual property, or that third parties will challenge our ownership rights or the validity of our patents. In addition, the laws of some foreign countries may not protect our proprietary rights to as great an extent as do the laws of the United States and it may be more difficult to monitor the use of our intellectual property. Our competitors may be able to legitimately ascertain non-patented proprietary technology embedded in our systems. If this occurs, we may not be able to prevent the development of technology substantially similar to ours.

We may have to resort to costly litigation to enforce our intellectual property rights, to protect our trade secrets or know-how or to determine their scope, validity or enforceability. Enforcing or defending our proprietary technology is expensive, could cause us to divert resources and may not prove successful. Our protective measures may prove inadequate to protect our proprietary rights, and if we fail to enforce or protect our rights, we could lose valuable assets.

V. Risks Related to Compliance, Environmental Regulations and Other Legal Matters

If we, or any of our partially owned supply chain companies, fail to comply with environmental and safety regulations, we may be subject to significant fines or forced to cease our operations.

We are subject to federal, state and local environmental and safety laws and regulations in all of our operating locations, including laws and regulations of China, such as laws and regulations related to the development, manufacture and use of our products, the use of hazardous materials, the operation of our facilities, and the use of our real property. These laws and regulations govern the use, storage, discharge and disposal of hazardous materials during manufacturing, research and development, and sales demonstrations. If we, or any of our partially owned supply chain companies, fail to comply with applicable regulations, we could be subject to substantial liability for clean-up efforts, personal injury, fines or suspension or be forced to close or temporarily cease our operations, and/or suspend or terminate the development, manufacture or use of certain of our products, the use of our facilities, or the use of our real property, each of which could have a material adverse effect on our business, financial condition and results of operations.

The Chinese central government is demonstrating strong leadership to improve air quality and reduce environmental pollution. These efforts have impacted manufacturing companies through mandatory shutdowns, increased inspections and regulatory reforms. In the fourth quarter of 2017, many manufacturing companies in the greater Beijing area, including AXT, were instructed by the local government to cease most manufacturing for several days until the air quality improved. In the first quarter of 2018, from February 27 to March 31 over 300 manufacturing companies were again intermittently shut down by the local government for a total of ten days, or 30 percent of the remaining calendar days, due to severe air pollution. Our shipments were delayed and our revenue for the quarter was negatively impacted. We expect that mandatory factory shutdowns will occur in the future. If the frequency of such shutdowns increases, especially at the end of a quarter, or if the total number of days of shutdowns prevents us from producing enough wafers to ship, then the shutdowns will have a material adverse effect on our manufacturing output, revenue and factory utilization. We are currently relocating our gallium arsenide and germanium manufacturing and are adding capacity at our new sites. We believe these efforts will mitigate our exposure to factory shutdowns. However, until the majority of our relocation is completed and our new facilities are in volume

production, there is no mitigation of the risk of mandatory factory shutdowns. Each of our 10 raw material supply chain companies could also be impacted by environmental related orders from the central government.

In addition, from time to time, the Chinese government issues new regulations, which may require additional actions on our part to comply. On February 27, 2015, the China State Administration of Work Safety updated its list of hazardous substances. The previous list, which was published in 2002, did not restrict the materials that we use in our

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wafers. The new list added gallium arsenide. As a result of the newly published list, we were instructed to obtain a permit to continue to manufacture our gallium arsenide substrate wafers. The Beijing municipal authority accepted our permit application in May 2015, but has not yet issued to us the requisite permit while we continue to show good faith and, more recently, significant progress in relocating our gallium arsenide production. If our application is denied in the future before we complete our relocation, then our gallium arsenide production could be disrupted, which could materially and adversely impact our results of operations and our financial condition.

We could be subject to suits for personal injuries caused by hazardous materials.

In 2005, a complaint was filed against us alleging personal injury, general negligence, intentional tort, wage loss and other damages, including punitive damages, as a result of exposure of plaintiffs to high levels of gallium arsenide in gallium arsenide wafers, and methanol. Other current and/or former employees could bring litigation against us in the future. Although we have in place engineering, administrative and personnel protective equipment programs to address these issues, our ability to expand or continue to operate our present locations could be restricted or we could be required to acquire costly remediation equipment or incur other significant expenses if we were found liable for failure to comply with environmental and safety regulations. Existing or future changes in laws or regulations in the United States and China may require us to incur significant expenditures or liabilities, or may restrict our operations. In addition, our employees could be exposed to chemicals or other hazardous materials at our facilities and we may be subject to lawsuits seeking damages for wrongful death or personal injuries allegedly caused by exposure to chemicals or hazardous materials at our facilities.

Litigation is inherently uncertain and while we would expect to defend ourselves vigorously, it is possible that our business, financial condition, results of operations or cash flows could be affected in any particular period by litigation pending and any additional litigation brought against us. In addition, future litigation could divert management's attention from our business and operations, causing our business and financial results to suffer. We could incur defense or settlement costs in excess of the insurance covering these litigation matters, or that could result in significant judgments against us or cause us to incur costly settlements, in excess of our insurance limits.

We are subject to internal control evaluations and attestation requirements of Section 404 of the Sarbanes Oxley Act.

Pursuant to Section 404 of the Sarbanes Oxley Act of 2002, we must include in our Annual Report on Form 10-K a report of management on the effectiveness of our internal control over financial reporting. Ongoing compliance with this requirement is complex, costly and time-consuming and it extends to our companies in China. If: (1) we fail to maintain effective internal control over financial reporting; or (2) our management does not timely assess the adequacy of such internal control, we could be subject to regulatory sanctions and the public's perception of us may be adversely impacted.

We need to continue to improve or implement our systems, procedures and controls.

We rely on certain manual processes for data collection and information processing, as do our joint venture companies. If we fail to manage these procedures properly or fail to effectively manage a transition from manual processes to automated processes, our systems and controls may be disrupted. To manage our business effectively, we may need to implement additional management information systems, further develop our operating, administrative, financial and accounting systems and controls, add experienced senior level managers, and maintain close coordination among our executive, engineering, accounting, marketing, sales and operations organizations.

Item 1B. Unresolved Staff Comments

None.

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Item 2. Properties

Our principal properties as of March 11, 2019 are as follows:

Location	Square Feet	Principal Use	Ownership
Fremont, CA	19,467	Administration	Operating lease, expires November 2020
Beijing, China	256,000	Production and Administration	Owned by AXT / Tongmei
DingXing, China	190,000	Production	Owned by AXT / Tongmei
Kazuo, China	69,000	Production	Owned by AXT / Tongmei
Xianxi, China	54,000	Production	Owned by Beijing JiYa Semiconductor Material Co., Ltd.*
Xianxi, China	7,100	Administration	Owned by Beijing JiYa Semiconductor Material Co., Ltd.*
Beijing, China	1,500	Administration	Operating lease by Beijing JiYa Semiconductor Material Co., Ltd., expires April 2019
Nanjing, China	5,400	R&D and Administration	Owned by Nanjing JinMei Gallium Co., Ltd.*
Kazuo, China	7,500	Production	Operating lease by Nanjing JinMei Gallium Co. Ltd. expires December 2019.*
Kazuo, China	71,000	Production and Administration	Owned by Beijing BoYu Semiconductor Vessel Craftwork Technology Co., Ltd.*
Beijing, China	37,660	Production and Administration	Operating leases by Beijing BoYu Semiconductor Vessel Craftwork Technology Co., Ltd., expire on various dates until November 2019.*

*Joint ventures in which we hold an interest and consolidate in our consolidated financial statements. We hold a 46% interest in Beijing JiYa Semiconductor Material Co., Ltd., a 97% interest in Nanjing JinMei Gallium Co., Ltd., and a 63% interest in Beijing BoYu Semiconductor Vessel Craftwork Technology Co., Ltd.

We consider each facility to be in good operating condition and adequate for its present use, and believe that each facility has sufficient plant capacity to meet its current and anticipated operating requirements.

Item 3. Legal Proceedings

From time to time we may be involved in judicial or administrative proceedings concerning matters arising in the ordinary course of business. We do not expect that any of these matters, individually or in the aggregate, will have a material adverse effect on our business, financial condition, cash flows or results of operation.

Item 4. Mine Safety Disclosures

Not applicable.

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PART II

Item 5. Market for Registrant’s Common Equity, Related Stockholder Matters and Issuer Purchases of Equity Securities

Our common stock has been trading publicly on the NASDAQ Global Select Market (NASDAQ) under the symbol “AXTI” since May 20, 1998, the date we consummated our initial public offering, and beginning on January 3, 2011, our common stock began trading on the NASDAQ Global Select Market under the same symbol. The following table sets forth the range of high and low sales prices of the common stock for the periods indicated, as reported by NASDAQ.

	High	Low
2018		
First Quarter	\$ 9.45	\$ 6.90
Second Quarter	\$ 8.60	\$ 5.80
Third Quarter	\$ 9.38	\$ 6.80
Fourth Quarter	\$ 7.24	\$ 3.93
2017		
First Quarter	\$ 8.65	\$ 4.68
Second Quarter	\$ 7.83	\$ 5.50
Third Quarter	\$ 9.50	\$ 5.95
Fourth Quarter	\$ 10.75	\$ 7.65

As of March 11, 2019, there were 133 holders of record of our common stock. Because many shares of AXT’s common stock are held by brokers and other institutions on behalf of stockholders, we are unable to estimate the total number of beneficial owners of our common stock.

We have never paid or declared any cash dividends on our common stock and do not anticipate paying cash dividends in the foreseeable future. Dividends accrue on our outstanding Series A preferred stock at the rate of \$0.20 per annum per share of Series A preferred stock. The 883,000 shares of Series A preferred stock issued and outstanding as of December 31, 2018 are valued at \$3,532,000 and are non-voting and non-convertible preferred stock with a 5.0% cumulative annual dividend rate payable when declared by our board of directors, and a \$4.00 per share liquidation preference over common stock that must be paid before any distribution is made to the holders of our common stock. These shares of preferred stock were issued to shareholders of Lyte Optronics, Inc. in connection with the completion of our acquisition of Lyte Optronics, Inc. on May 28, 1999. By the terms of the Series A preferred stock, so long as any shares of Series A preferred stock are outstanding, neither the Company nor any subsidiary of the Company shall redeem, repurchase or otherwise acquire any shares of common stock, unless all accrued dividends on the Series A preferred stock have been paid. During 2013 and 2015, we repurchased shares of our outstanding common stock. As of December 31, 2015, the Series A preferred stock had cumulative dividends of \$2.9 million and we include such cumulative dividends in “Accrued liabilities” in our consolidated balance sheets. No shares were repurchased during 2018, 2017 and 2016 under this program. If we are required to pay the cumulative dividends on the Series A preferred stock, our cash and cash equivalents would be reduced. We account for the cumulative year to date dividends on the Series A preferred stock when calculating our earnings per share.

Issuer Purchases of Equity Securities

On February 21, 2013, our Board of Directors approved a stock repurchase program pursuant to which we could repurchase up to \$6.0 million of our outstanding common stock through February 27, 2014. The purchases could be made from time to time in the open market and were to be funded from our existing cash balances and cash generated from operations. During 2013, we repurchased approximately 285,000 shares at an average price of \$2.52 per share for a total purchase price of \$716,000 under the stock repurchase program. As of December 31, 2013, approximately \$5.3 million remained available for future repurchases under this program. No shares were repurchased in 2014 under this program and the plan expired on February 27, 2014.

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On October 27, 2014, our Board of Directors approved a stock repurchase program pursuant to which we may repurchase up to \$5.0 million of our outstanding common stock. These repurchases can be made from time to time in the open market and are funded from our existing cash balances and cash generated from operations. During 2015, we repurchased approximately 908,000 shares at an average price of \$2.52 per share for a total purchase price of approximately \$2.3 million under the stock repurchase program. No shares were repurchased during 2018 or 2017 under this program. As of December 31, 2018 and 2017, approximately \$2.7 million remained available for future repurchases under this program, respectively.

Comparison of Stockholder Return

Set forth below is a line graph comparing the annual percentage change in the cumulative total return to the stockholders of the Company on our common stock with the CRSP Total Return Index for the Nasdaq Stock Market (U.S. Companies) and the Nasdaq Electronic Components Index for the period commencing December 31, 2013 and ending December 31, 2018.

	12/13	12/14	12/15	12/16	12/17	12/18
AXT, Inc.	100	107.28	95.02	183.91	333.33	166.67
NASDAQ Composite	100	114.62	122.8	133	172.11	165.84
NASDAQ Electronic Components	100	133.28	130.82	169.00	240.33	213.45

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Item 6. Selected Consolidated Financial Data

The following selected consolidated financial data is derived from and should be read in conjunction with our consolidated financial statements and related notes set forth in Item 8 below, and in our previously filed reports on Form 10 K. See also Item 7. "Management's Discussion and Analysis of Financial Condition and Results of Operations" for further information relating to items reflecting our results of operations and financial condition.

	Year Ended December 31,				
	2018	2017	2016	2015	2014
	(in thousands, except per share data)				
Statements of Operations Data:					
Revenue	\$ 102,397	\$ 98,673	\$ 81,349	\$ 77,502	\$ 83,499
Cost of revenue	65,350	64,198	54,968	60,673	66,332
Gross profit	37,047	34,475	26,381	16,829	17,167
Operating expenses:					
Selling, general and administrative	19,003	17,009	13,880	16,064	14,970
Research and development	5,897	4,827	5,850	5,664	4,144
Restructuring charge	—	—	226	—	907
Total operating expenses	24,900	21,836	19,956	21,728	20,021
Income (loss) from operations	12,147	12,639	6,425	(4,899)	(2,854)
Interest income, net	528	461	409	412	483
Equity in (loss) earnings of unconsolidated joint ventures	(1,080)	(1,694)	(1,995)	462	1,528
Other income (expense), net	352	(553)	860	2,023	361
Income (loss) before provision for income taxes	11,947	10,853	5,699	(2,002)	(482)
Provision for income taxes	938	792	733	531	215
Net income (loss)	11,009	10,061	4,966	(2,533)	(697)
Less: Net (income) loss attributable to noncontrolling interests	(1,355)	87	670	305	(691)
Net income (loss) attributable to AXT, Inc.	\$ 9,654	\$ 10,148	\$ 5,636	\$ (2,228)	\$ (1,388)
Net income (loss) attributable to AXT, Inc. per common share:					
Basic	\$ 0.24	\$ 0.27	\$ 0.17	\$ (0.07)	\$ (0.05)
Diluted	\$ 0.24	\$ 0.26	\$ 0.17	\$ (0.07)	\$ (0.05)
Shares used in per share calculations:					
Basic	39,049	37,444	32,139	32,183	32,452
Diluted	40,265	38,966	32,894	32,183	32,452

	December 31,				
	2018	2017	2016	2015	2014
	(in thousands)				
Balance Sheet Data:					
Cash and cash equivalents	\$ 16,526	\$ 44,352	\$ 36,152	\$ 24,875	\$ 28,814

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Investments	22,846	32,608	17,571	19,128	20,123
Working capital	99,831	117,927	91,335	81,146	85,668
Total assets	223,524	211,200	154,246	151,896	161,517
Current liabilities	28,709	22,594	15,951	15,742	17,525
Stockholders' equity	194,532	188,317	137,390	134,660	141,934

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Item 7. Management's Discussion and Analysis of Financial Condition and Results of Operations

In addition to historical information, the following discussion contains forward looking statements that are subject to risks and uncertainties. Actual results may differ substantially from those referred to herein due to a number of factors, including but not limited to risks described in the section entitled Item 1A. "Risk Factors" and elsewhere in this Annual Report on Form 10-K. This discussion should be read in conjunction with Item 6. "Selected Consolidated Financial Data" and our consolidated financial statements and related notes included elsewhere in this Form 10-K.

Restructuring Charges

In the second quarter of 2016, we restructured the operations of Beijing JiYa Semiconductor Material Co., Ltd., one of our partially owned consolidated subsidiaries, which resulted in a reduction in force of 28 positions that were no longer required to support production and operations. Accordingly, we recorded a restructuring charge of approximately \$226,000 related to the reduction in force for severance-related expenses. As of June 30, 2016, we had completed this restructuring plan and the reduction in force. We did not have any restructuring charges in 2018 and 2017.

Critical Accounting Policies and Estimates

We prepare our consolidated financial statements in accordance with accounting principles generally accepted in the United States of America. Accordingly, we make estimates, assumptions and judgments that affect the amounts reported on our consolidated financial statements. These estimates, assumptions and judgments about future events and their effects on our results cannot be determined with certainty, and are made based upon our historical experience and on other assumptions that are believed to be reasonable under the circumstances. These estimates may change as new events occur or additional information is obtained, and we may periodically be faced with uncertainties, the outcomes of which are not within our control and may not be known for a prolonged period of time.

We have identified the policies below as critical to our business operations and understanding of our financial condition and results of operations. Critical accounting policies are material to the presentation of our consolidated financial statements and require us to make difficult, subjective or complex judgments that could have a material effect on our financial condition and results of operations. They may require us to make assumptions about matters that are highly uncertain at the time of the estimate. Different estimates that we could have used, or changes in the estimate that are reasonably likely to occur, may have a material impact on our financial condition or results of operations. We also refer you to Note 1 to our consolidated financial statements included elsewhere in this Form 10-K.

Revenue Recognition

We manufacture and sell high-performance compound semiconductor substrates including indium phosphide, gallium arsenide and germanium wafers, and our three consolidated subsidiaries sell certain raw materials, including 99.99% pure gallium (4N Ga), high purity gallium (7N Ga), pyrolytic boron nitride (pBN) crucibles and boron oxide (B2O3). After we ship our products, there are no remaining obligations or customer acceptance requirements that would preclude revenue recognition. Our products are typically sold pursuant to purchase orders placed by our customers, and our terms and conditions of sale do not require customer acceptance. We account for a contract with a customer when there is a legally enforceable contract, which could be the customer's purchase order, the rights of the parties are identified, the contract has commercial terms, and collectibility of the contract consideration is probable. The majority of our contracts have a single performance obligation to transfer products and are short term in nature, usually less than six months. Our revenue is measured based on the consideration specified in the contract with each customer in exchange for transferring products that are generally based upon a negotiated, formula, list or fixed price. Revenue is

recognized when control of the promised goods is transferred to our customer, which is either upon shipment from our dock, receipt at the customer's dock, or removal from consignment inventory at the customer's location, in an amount that reflects the consideration we expect to be entitled to receive in exchange for those goods.

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We have elected to account for shipping and handling as activities to fulfill the promise to transfer the goods. As such, shipping and handling fees billed to customers in a sales transaction are recorded in revenue. Shipping and handling costs incurred are recorded in cost of revenue. Sales taxes and value added taxes in foreign jurisdictions that are collected from customers and remitted to governmental authorities are accounted for on a net basis and, therefore, are excluded from net sales.

We do not provide training, installation or commissioning services. We accrue for future returns based on historical data, prior experience, current economic trends and changes in customer demand at the time revenue is recognized. We do not recognize any asset associated with the incremental cost of obtaining revenue generating customer contracts. As such, sales commissions and other related expenses are expensed as incurred, given that the expected period of benefit is less than one year.

On January 1, 2018, we adopted Accounting Standards Codification (“ASC”) Topic 606, Revenue from Contracts with Customers (“ASC 606”), and its related amendments, using the modified retrospective method applied to those contracts which were not completed as of January 1, 2018. The adoption of ASC 606, using the modified retrospective approach, had no significant impact to our accumulated deficit as of January 1, 2018 and no significant impact to the total net cash from or used in operating, investing, or financing activities within the consolidated statements of cash flows. In connection with this adoption on January 1, 2018, we reclassified our refund liabilities relating to sales with a right of return in the amount of \$169,000 to present it separately from “Accounts receivables” and included it in “Accrued liabilities” on the consolidated balance sheets. See Note 1 for the required disclosures related to the impact of adopting this standard and a discussion of the Company’s updated policies related to revenue recognition.

Accounts Receivable, Allowance for Doubtful Accounts and Allowance for sales returns

Accounts receivables are recorded at the invoiced amount and are not interest bearing. We periodically review the likelihood of collection on our accounts receivable balances and provide an allowance for doubtful accounts receivable primarily based upon the age of these accounts. We evaluate receivables from U.S. customers with an emphasis on balances in excess of 90 days and for receivables from customers located outside the U.S. with an emphasis on balances in excess of 120 days and establish a reserve allowance on the receivable balances if needed. The reason for the difference in the evaluation of receivables between foreign and U.S. customers is that U.S. customers have historically made payments in a shorter period of time than foreign customers. Foreign business practices generally require us to allow customer payment terms that are longer than those accepted in the United States. We assess the probability of collection based on a number of factors, including the length of time a receivable balance has been outstanding, our past history with the customer and the customer’s credit-worthiness.

We exercise judgment when determining the adequacy of our reserves as we evaluate historical bad debt trends, general economic conditions in the United States and internationally, and changes in customer financial conditions. Uncollectible receivables are recorded as bad debt expense when all efforts to collect have been exhausted and recoveries are recognized when they are received. As of December 31, 2018 and 2017, our accounts receivable, net balance was \$19.6 million and \$22.8 million, respectively, which was net of an allowance for doubtful accounts of \$358,000 in both December 31, 2018 and 2017. There were no changes in the allowance of doubtful accounts in 2018.

During 2017, we decreased the allowance for doubtful accounts by \$295,000 due to \$138,000 from bad debt recovery and \$157,000 from bad debts written off in 2017. If actual uncollectible accounts differ substantially from our estimates, revisions to the estimated allowance for doubtful accounts would be required, which could have a material impact on our financial results.

Historically, our allowance for sales returns reserve was deducted from gross accounts receivable. In connection with the adoption of ASC Topic 606, on January 1, 2018, we reclassified our refund liabilities relating to sales with a right of return in the amount of \$169,000 to present it separately from “Accounts receivables” and included it in “Accrued liabilities” on the consolidated balance sheets. As of December 31, 2018 and 2017, the balance was \$47,000 and \$169,000, respectively.

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Warranty Reserve

We maintain a warranty reserve based upon our claims experience during the prior twelve months and any pending claims and returns of which we are aware. Warranty costs are accrued at the time revenue is recognized. As of December 31, 2018 and 2017, accrued product warranties totaled \$236,000 and \$133,000, respectively. The increase in accrued product warranties is primarily attributable to increased claims for quality issues experienced by customers. If actual warranty costs or pending new claims differ substantially from our estimates, revisions to the estimated warranty liability would be required, which could have a material impact on our financial condition and results of operations for future periods.

Inventory Valuation

Inventories are stated at the lower of cost (approximated by standard cost) or net realizable value. Cost is determined using the weighted average cost method. Our inventory consists of raw materials as well as finished goods and work-in-process that include material, labor and manufacturing overhead costs. We routinely evaluate the levels of our inventory in light of current market conditions in order to identify excess and obsolete inventory, and we provide a valuation allowance for certain inventories based upon the age and quality of the product and the projections for sale of the completed products. As of December 31, 2018 and 2017, we had an inventory reserve of \$14.8 million and \$13.3 million, respectively, for excess and obsolete inventory and \$18,000 and \$291,000, respectively, for lower of cost or net realizable value reserves. If actual demand for our products were to be substantially lower than estimated, additional inventory adjustments for excess or obsolete inventory might be required, which could have a material impact on our business, financial condition and results of operations.

Impairment of Investments

We classify marketable investments in debt and equity securities as available-for-sale securities in accordance with ASC Topic 320, Investments—Debt and Equity Securities. All available-for-sale securities with a quoted market value below cost (or adjusted cost) are reviewed in order to determine whether the decline is other-than-temporary. Factors considered in determining whether a loss is temporary include the magnitude of the decline in market value, the length of time the market value has been below cost (or adjusted cost), credit quality, and our ability and intent to hold the securities for a period of time sufficient to allow for any anticipated recovery in market value.

We also invest in equity instruments of privately-held companies in China for business and strategic purposes. Investments in our unconsolidated joint venture companies are classified as other assets and accounted for under either the equity or cost method, depending on whether we have the ability to exercise significant influence over their operations or financial decisions. We monitor our investments for impairment and record reductions in carrying value when events or changes in circumstances indicate that the carrying value may not be recoverable. Determination of impairment is highly subjective and is based on a number of factors, including an assessment of the strength of the subsidiary's management, the length of time and extent to which the fair value has been less than our cost basis, the financial condition and near-term prospects of the subsidiary, fundamental changes to the business prospects of the subsidiary, share prices of subsequent offerings, and our intent and ability to hold the investment for a period of time sufficient to allow for any anticipated recovery in our carrying value.

For the year ended December 31, 2018, we have no impairment charges. For the year ended December 31, 2017, we had included an impairment charge of \$313,000 for one of the gallium companies. During the first quarter of 2017, management determined it unlikely that this company will recover from the difficult pricing environment and we wrote the investment down to zero. We had no impairment charges during 2016.

Fair Value of Investments

ASC Topic 820, Fair Value Measurement establishes three levels of inputs that may be used to measure fair value.

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Level 1 instruments represent quoted prices in active markets. Therefore, determining fair value for Level 1 instruments does not require significant management judgment, and the estimation is not difficult.

Level 2 instruments include observable inputs other than Level 1 prices, such as quoted prices for similar instruments in markets with insufficient volume or infrequent transactions (less active markets), issuer bank statements, credit ratings, non-binding market consensus prices that can be corroborated with observable market data, model-derived valuations in which all significant inputs are observable or can be derived principally from or corroborated with observable market data for substantially the full term of the assets or liabilities, or quoted prices for similar assets or liabilities. These Level 2 instruments require more management judgment and subjectivity compared to Level 1 instruments, including:

- Determining which instruments are most comparable to the instrument being priced requires management to identify a sample of similar securities based on the coupon rates, maturity, issuer, credit rating, and instrument type, and subjectively select an individual security or multiple securities that are deemed most similar to the security being priced.
- Determining which model-derived valuations to use in determining fair value requires management judgment. When observable market prices for similar securities or similar securities are not available, we price our marketable debt instruments using non-binding market consensus prices that are corroborated with observable market data or pricing models, such as discounted cash flow models, with all significant inputs derived from or corroborated with observable market data.

Level 3 instruments include unobservable inputs to the valuation methodology that are significant to the measurement of fair value of assets or liabilities. The determination of fair value for Level 3 instruments requires the most management judgment and subjectivity.

We place short-term foreign currency hedges that are intended to offset the potential cash exposure related to fluctuations in the exchange rate between the United States dollar and Japanese yen. We measure the fair value of these foreign currency hedges at each month end and quarter end using current exchange rates and in accordance with generally accepted accounting principles. At quarter end any foreign currency hedges not settled are netted in “Accrued liabilities” on the consolidated balance sheet and classified as Level 3 assets and liabilities. As of December 31, 2018 and 2017, the net change in fair value from the placement of the hedge to settlement at each month end during the quarter had a de minimis impact to the consolidated results.

Impairment of Long-Lived Assets

We evaluate the recoverability of property, equipment and intangible assets in accordance with ASC Topic 360, Property, Plant and Equipment. When events and circumstances indicate that long-lived assets may be impaired, we compare the carrying value of the long-lived assets to the projection of future undiscounted cash flows attributable to such assets. In the event that the carrying value exceeds the future undiscounted cash flows, we record an impairment charge against income equal to the excess of the carrying value over the asset’s fair value. Fair values are determined based on quoted market values, discounted cash flows or internal and external appraisals, as applicable. Assets held for sale are carried at the lower of carrying value or estimated net realizable value. We had no “Assets held for sale” or any impairment of long-lived assets on the consolidated balance sheets as of December 31, 2018 and 2017.

Stock-Based Compensation

We account for stock-based compensation in accordance with ASC Topic 718, Stock-based Compensation. Share-based awards granted include stock options and restricted stock awards. We utilize the Black-Scholes option pricing model to estimate the grant date fair value of stock options, which requires the input of highly subjective assumptions, including estimating stock price volatility and expected term. Historical volatility of our stock price was

used while the expected term for our options was estimated based on historical option exercise behavior and post-vesting forfeitures of options, and the contractual term, the vesting period and the expected term of the outstanding options. Further, we apply an expected forfeiture rate in determining the amount of share-based compensation. We use historical

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forfeitures to estimate the rate of future forfeitures. Changes in these inputs and assumptions can materially affect the measure of estimated fair value of our stock compensation. The cost of restricted stock awards is determined using the fair value of our common stock on the date of grant.

We recognize the compensation costs net of an estimated forfeiture rate over the requisite service period of the options award, which is generally the vesting term of four years. Compensation expense for restricted stock awards is recognized over the vesting period, which is generally one, three or four years. Stock-based compensation expense is recorded in cost of revenue, research and development, and selling, general and administrative expenses. (see Note 1—Summary of Significant Accounting Policies—Stock Based Compensation).

In March 2016, the Financial Accounting Standards Board (“FASB”) issued Accounting Standards Update (“ASU”) 2016-09, Improvements to Employee Share-Based Payment Accounting. This ASU affects entities that issue share-based payment awards to their employees. The ASU is designed to simplify several aspects of accounting for share-based payment award transactions which include the income tax consequences, classification of awards as either equity or liabilities, classification on the statement of cash flows and forfeiture rate calculations. ASU 2016-09 was effective for public companies for annual periods and interim periods within those annual periods beginning after December 15, 2016. We adopted this ASU as of January 1, 2017. The adoption of ASU 2016-09 did not have a material effect on our consolidated financial statements.

Income Taxes

We account for income taxes in accordance with ASC topic 740, Income Taxes (“ASC 740”), which requires that deferred tax assets and liabilities be recognized using enacted tax rates for the effect of temporary differences between the book and tax bases of recorded assets and liabilities. ASC 740 also requires that deferred tax assets be reduced by a valuation allowance if it is more likely than not that a portion of the deferred tax asset will not be realized. Our deferred tax assets have been reduced to zero by valuation allowance.

We provide for income taxes based upon the geographic composition of worldwide earnings and tax regulations governing each region, particularly China. The calculation of tax liabilities involves significant judgment in estimating the impact of uncertainties in the application of complex tax laws, particularly in foreign countries such as China.

See Note 12—“Income Taxes” in the consolidated financial statements for additional information.

Results of Operations

Overview

We were founded in 1986 to commercialize and enhance our proprietary vertical gradient freeze (VGF) technology for producing high-performance compound semiconductor substrates or wafers. We have one operating segment and two product lines: specialty material substrates and raw materials used to make such substrates or other related products. We recorded our first substrate sales in 1990 and our substrate products currently include indium phosphide (InP), gallium arsenide (GaAs) and germanium (Ge) substrates used to produce semiconductor devices for use in applications such as fiber optic and wireless telecommunications, light emitting diodes (LEDs), lasers and for solar cells for space and terrestrial photovoltaic applications. We also sell raw materials, including gallium and germanium, through our participation in majority and minority owned subsidiaries and joint ventures.

Operating Results

We manufacture all of our products in the People's Republic of China (PRC or China), which generally has favorable costs for facilities and labor compared with comparable facilities in the United States, Europe or Japan. Our supply chain includes partial ownership of 10 companies in China (joint ventures). We believe this supply chain arrangement provides us with pricing advantages, reliable supply and enhanced sourcing lead-times for key raw materials which are central to our final manufactured products.

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Our annual revenue has grown for the last three consecutive years. Our revenue increased in 2018 by 4 percent to \$102.4 million, in 2017 by 21 percent to \$98.7 million and in 2016 our revenue increased by 5 percent to \$81.3 million. Gross margins also improved to 36.2% of total revenue in 2018 from 34.9% of total revenue in 2017 and from 32.4% of total revenue in 2016. During the four years from 2012 to 2015 our revenue declined, primarily as a result of the adoption of an alternative technology, SOI, which entered the market in 2011. SOI enabled the RF switching chip in cell phones to function satisfactorily at a reduced cost. Before 2011, silicon did not perform adequately in this function due to power consumption, heat and speed issues.

In 2014, our revenue from InP began to grow and, in 2014 and 2015, the InP annual growth rate exceeded 50% year on year. This mitigated the reduction in revenue from gallium arsenide and enabled us to return to annual growth in 2016. During this period, we believe our GaAs wafer business stabilized and our manufacturing yields improved. Our outlook for GaAs wafer substrates today is positive, as it is for InP and Ge substrates. Each of these substrates has end market applications that we believe are growing. We are continuing to improve our six-inch low defect density or low EPD GaAs substrates that are required for 3D-sensing using VCSELs. We are in the process of relocating our GaAs and Ge manufacturing lines and believe this will enable us to add capacity quickly in the future if market demands so require.

Revenue

	Years Ended Dec. 31			2017 to 2018		2016 to 2017			
	2018	2017	2016	Increase (Decrease)	% Change	Increase (Decrease)	% Change		
Product Type:									
Substrates	\$ 81,008	\$ 78,619	\$ 65,633	\$ 2,389	3.0	% \$ 12,986	19.8	%	
Raw Materials and									
Others	21,389	20,054	15,716	1,335	6.7	% 4,338	27.6	%	
Total revenue	\$ 102,397	\$ 98,673	\$ 81,349	\$ 3,724	3.8	% \$ 17,324	21.3	%	

Revenue increased \$3.7 million, or 3.8% in 2018 from \$98.7 million in 2017. The \$2.4 million increase in substrate sales primarily came from growth of our InP and Ge wafer substrate sales in 2018, which is partially offset by a modest decrease of our GaAs wafer substrate sales as compared to the same period of 2017. The \$1.3 million increase in raw materials sales from our consolidated subsidiaries came from a 31% increase in raw gallium sales and a 28% increase in pBN sales as compared to 2017, which is partially offset by the decrease in purified gallium sales from one of our consolidated subsidiaries. During 2018, the average selling prices of our wafers decreased slightly. The revenue increase was the result of higher unit volume in 2018 as compared to the same period in 2017.

Revenue increased \$17.3 million, or 21.3% in 2017 from \$81.3 million in 2016. The \$13.0 million increase in substrate sales came from a 17% or more increase in sales from each of our wafer substrate products while the \$4.3 million increase in raw materials sales from our consolidated subsidiaries came from a 40% increase in pBN sales and a 29% increase in refined gallium sales as compared to 2016. Except for the average selling price of Ge wafers, the average selling prices of our wafers increased slightly in 2017. The revenue increase was the result of higher unit volume and higher average selling prices.

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Revenue by Geographic Region

	Year Ended Dec. 31,						2017 to 2018		2016 to 2017	
	2018	2017		2016		Increase (Decrease)	% Change	Increase (Decrease)	% Change	
	(\$ in thousands)									
China	\$ 31,492	\$ 24,962		\$ 17,448		\$ 6,530	26.2	% \$ 7,514	43.1	%
% of total revenue	31	%	25	%	21	%				
Europe (primarily Germany)	22,013	23,956		18,637		(1,943)	(8.1)	% 5,319	28.5	%
% of total revenue	21	%	24	%	23	%				
Taiwan	20,078	18,279		15,369		1,799	9.8	% 2,910	18.9	%
% of total revenue	20	%	19	%	19	%				
Japan	10,305	13,258		11,015		(2,953)	(22.3)	% 2,243	20.4	%
% of total revenue	10	%	13	%	14	%				
North America (primarily the United States)	10,021	8,352		8,084		1,669	20.0	% 268	3.3	%
% of total revenue	10	%	9	%	10	%				
Asia Pacific (excluding China, Taiwan and Japan)	8,488	9,866		10,796		(1,378)	(14.0)	% (930)	(8.6)	%
% of total revenue	8	%	10	%	13	%				
Total revenue	\$ 102,397	\$ 98,673		\$ 81,349		\$ 3,724	3.8	% \$ 17,324	21.3	%

Sales to customers located outside of North America represented approximately 90%, 91% and 90% of our revenue during 2018, 2017 and 2016, respectively.

Revenue from customers in China increased in 2018 by 26.2%, primarily due to an increase of \$1.2 million, or 12%, from raw materials sales and an increase of \$5.3 million, or 36%, from wafer substrate sales. Sales of all three of our wafer substrate products in China increased in 2018. Revenue from customers in Europe decreased by 8.1%, primarily due to a decrease of \$1.6 million, or 75.5%, in gallium sales from our consolidated joint ventures and from a decrease of \$0.7 million, or 3%, from wafer substrate sales. Revenue from customers in Japan decreased in 2018 by 22.3% due to a decrease of \$3.9 million in GaAs wafer substrate sales. However, sales from InP and Ge wafer substrates and raw materials in Japan all increased in 2018 as compared to 2017. Revenue from customers in Taiwan increased by 9.8%, primarily due to strong demand for InP substrates used in silicon photonics, specifically in data center expansions and upgrades.

Revenue from customers in China increased by 43.1% in 2017, primarily due to an increase of \$5.0 million, or 93%, from raw materials sales and an increase of \$2.5 million, or 21%, from wafer substrate sales. Sales of all three of our wafer substrate products in China grew in 2017. The growth of Ge substrates that we experienced in 2016 continued into 2017 as the satellite solar cell market remained strong in 2017. GaAs substrate sales in 2017 also increased, primarily due to an increase from our semi-conducting GaAs substrates, which was partially offset by decreased sales of semi-insulating GaAs substrates. Revenue from customers in Europe increased by 28.5%, primarily due to an increase of \$5.3 million, or 35%, from wafer substrate sales, while raw materials sales from our consolidated joint ventures sales remained the same in 2017. Revenue from customers in Taiwan increased by 18.9%, primarily due to strong demand for InP substrates used in silicon photonics, specifically in data center expansions and upgrades. Revenue from customers in Japan increased in 2017 by 20.4% due to increases in both substrate and raw material sales.

Gross Margin

	Year Ended Dec. 31,		2016	2017 to 2018		2016 to 2017			
	2018	2017		Increase (Decrease)	% Change	Increase (Decrease)	% Change		
	(\$ in thousands)								
Gross profit	\$ 37,047	\$ 34,475	\$ 26,381	\$ 2,572	7.5	% \$ 8,094	30.7	%	
Gross Margin %	36.2	% 34.9	% 32.4						

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Gross margin increased to 36.2% of total revenue in 2018 from 34.9% of total revenue in 2017. Gross margin increased in 2018 as a result of an increase in gross margins from raw materials sales, particularly pBN crucibles, and InP wafer substrates offset by a slight decrease in gross margins from sales of GaAs wafer substrates. Substrate gross margin slightly decreased to 36.2% of substrate revenue in 2018 from 37.4% of revenue in 2017 and raw materials gross margin increased to 36.2% of raw materials revenue in 2018 from 25.5% of raw materials revenue in 2017. Gross profit increased primarily due to favorable substrate product mix, increased revenue and improvement in raw materials gross margin.

Gross margin increased to 34.9% of total revenue in 2017 from 32.4% of total revenue in 2016. Gross margin increased in 2017 as a result of an increase in gross margins from sales of raw materials and GaAs and Ge wafer substrates. Substrate gross margin increased to 37.4% of substrate revenue in 2017 from 34.7% of revenue in 2016 and raw materials gross margin increased to 25.5% of raw materials revenue in 2017 from 23.0% of raw materials revenue in 2016. Gross profit increased primarily due to favorable product mix, higher production volume, overall improvements in yield and manufacturing efficiencies and lower raw material costs used in our wafer substrates in 2017 as compared to 2016. However, the effect of these favorable factors was partially offset by higher excess and obsolescence charges in 2017 as compared to 2016.

Selling, General and Administrative Expenses

	Years Ended Dec. 31			2017 to 2018		2016 to 2017		
	2018	2017	2016	Increase (Decrease)	% Change	Increase (Decrease)	% Change	
	(\$ in thousands)							
Selling, general and administrative expenses	\$ 19,003	\$ 17,009	\$ 13,880	\$ 1,994	11.7	% \$ 3,129	22.5	%
% of total revenue	18.6	% 17.2	% 17.1	%				

Selling, general and administrative expenses increased \$2.0 million, or 11.7%, to \$19.0 million for 2018 compared to \$17.0 million for 2017. The higher selling, general and administrative expenses were primarily from higher personnel-related costs from hiring additional staff in China in connection with the relocation of our gallium arsenide and germanium production lines and a new direct sales professional in Europe, higher travel expenses related to traveling for customer visits and to our new manufacturing sites and higher stock compensation expenses, which were partially offset by lower professional service fees and lower sales commission expense that resulted from the termination of our European sales representative.

Selling, general and administrative expenses increased \$3.1 million, or 22.5%, to \$17.0 million for 2017 compared to \$13.9 million for 2016. The higher selling, general and administrative expenses were primarily from higher legal fees, marketing consultants, severance pay and personnel related costs as well as from expenses incurred as a result of the business interruption caused by the electrical fire in our Beijing facility on the evening of March 15, 2017.

Research and Development Expenses

Years Ended Dec. 31			2017 to 2018		2016 to 2017	
	2018	2017	2016	Increase (Decrease)	% Change	Increase (Decrease)

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(\$ in thousands)

Research and development	\$ 5,897	\$ 4,827	\$ 5,850	\$ 1,070	22.2	%	\$ (1,023)	(17.5)	%
% of total revenue	5.8	%	4.9	%	7.2	%			

Research and development expenses increased \$1.1 million, or 22.2%, to \$5.9 million in 2018 from \$4.8 million in 2017. The increase in research and development expenses in 2018 was primarily due to the increased use of raw materials for product development programs, particularly for low EPD-related programs and for improving Ge performance specifications, higher personnel-related costs and higher depreciation expenses.

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Research and development expenses decreased \$1.0 million, or 17.5%, to \$4.8 million for 2017 from \$5.9 million for 2016. The decrease in research and development expenses in 2017 was primarily due to the reduced use of raw materials for product development and lower personnel-related costs at our consolidated subsidiaries. Research and development for AXT substrates increased in 2017 by approximately 8%.

Restructuring Charges

We had no restructuring charges in 2018 and 2017. In the second quarter of 2016, we restructured the operations of Beijing JiYa Semiconductor Material Co., Ltd., which resulted in a reduction in force of 28 positions that were no longer required to support production and operations. Accordingly, we recorded a restructuring charge of approximately \$226,000 related to the reduction in force for severance-related expenses. As of June 30, 2016, we had completed this restructuring plan and the reduction in force.

Interest Income, Net

	Years Ended Dec. 31			2017 to 2018		2016 to 2017		
	2018	2017	2016	Increase (Decrease)	% Change	Increase (Decrease)	% Change	
Interest income, net	\$ 528	\$ 461	\$ 409	\$ 67	14.5	% \$ 52	12.7	%
% of total revenue	0.5 %	0.5 %	0.5 %					

Interest income, net increased in 2018 as compared to the same period in 2017, primarily due to higher market interest rates. Interest income, net increased in 2017 as compared to 2016, primarily due to increased cash balances as a result of the secondary public offering in March 2017.

Equity in Loss of Unconsolidated Joint Venture Companies

	Years Ended Dec. 31			2017 to 2018		2016 to 2017		
	2018	2017	2016	Increase (Decrease)	% Change	Increase (Decrease)	% Change	
Equity in loss of unconsolidated joint ventures	\$ (1,080)	\$ (1,694)	\$ (1,995)	\$ (614)	(36.2)	% \$ (301)	15.1	%
% of total revenue	(1.1) %	(1.7) %	(2.5) %					

Equity in loss of unconsolidated joint ventures is the aggregate net loss from our seven minority-owned supply chain joint venture companies that are not consolidated. Equity in loss of unconsolidated joint ventures decreased \$0.6 million to a loss of \$1.1 million in 2018 from a loss of \$1.7 million in 2017 as our unconsolidated joint ventures reported better performance in 2018 as compared to 2017. The loss in 2018 primarily came from a single minority-owned supply chain joint venture company that was required to temporarily shut down during the fourth quarter of 2018 to install manufacturing improvements mandated by a regional environmental agency. This resulted in a \$1.1 million charge in the fourth quarter and a cumulative loss of \$1.4 million for this entity in 2018. The decrease of \$0.6 million in 2018 from 2017 resulted from price increases of raw materials in 2018. Further, there were no

impairment charges in 2018 as compared to a charge of \$313,000 in 2017.

Equity in loss of unconsolidated joint ventures decreased \$0.3 million to a loss of \$1.7 million for 2017 from a loss of \$2.0 million for 2016 as our unconsolidated joint ventures had reported better performance in 2017 as compared to 2016. The loss in 2017 is the result of continuing low average selling prices for raw materials. The \$1.7 million net loss from our unconsolidated joint ventures included an impairment charge of \$313,000 for one of the gallium companies. During the first quarter of 2017, management determined it was unlikely that this company would recover from the difficult pricing environment and we wrote the investment down to zero.

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Other Income (expense), Net

	Years Ended Dec. 31			2017 to 2018		2016 to 2017		
	2018	2017	2016	Increase (Decrease)	% Change	Increase (Decrease)	% Change	
	(\$ in thousands)							
Other income (expense), net	\$ 352	\$ (553)	\$ 860	\$ 905	163.7	% \$ (1,413)	(164.3)	%
% of total revenue	0.3	% (0.6)	% 1.1	%				

Other income, net increased \$0.9 million to an income of \$0.4 million for 2018 as compared to a loss of \$0.6 million in 2017, primarily due to a higher foreign exchange gain in 2018 as compared to 2017.

Other expense, net decreased \$1.4 million to a loss of \$0.6 million for 2017 from income of \$0.9 million for 2016, primarily due to a lower realized gain recognized from sales of stock of GCS Holdings, Inc. (“GHI”) in 2017 as compared to 2016. As of December 31, 2017, we no longer held any GHI stock.

Provision for Income Taxes

	Years Ended Dec. 31			2017 to 2018		2016 to 2017		
	2018	2017	2016	Increase (Decrease)	% Change	Increase (Decrease)	% Change	
	(\$ in thousands)							
Provision for income taxes	\$ 938	\$ 792	\$ 733	\$ 146	18.4	% \$ 59	8.0	%
% of total revenue	0.9	% 0.8	% 0.9	%				

Provision for income taxes for 2018 and 2017 were \$0.9 million and \$0.8 million, respectively, which were mostly related to our wholly owned subsidiary in China and our three partially owned consolidated raw material companies. No income taxes or benefits have been provided for U.S. operations as the income in the U.S. had been fully offset by utilization of federal and state net operating loss carryforwards. Additionally, there is uncertainty of generating future profit in the U.S., which has resulted in our deferred tax assets being fully reserved. Our estimated tax rate can vary greatly from year to year because of the change or benefit in the mix of taxable income between our U.S. and China-based operations.

Due to our uncertainty regarding our future profitability in the U.S., we recorded a full valuation allowance against our net deferred tax assets of \$20 million in 2018, \$22 million in 2017 and \$68 million in 2016.

Net Loss Attributable to Noncontrolling Interests

	Years Ended Dec. 31			2017 to 2018		2016 to 2017		
	2018	2017	2016	Net Income (Increase)	% Change	Net Income (Increase)	% Change	
	(\$ in thousands)							

Net (income) loss attributable to noncontrolling interests	\$ (1,355)	\$ 87	\$ 670	\$ (1,442)	1,657.5	%	\$ (583)	(87.0)	%
% of total revenue	(1.3)	%	0.1	%	0.8	%			

The increase in noncontrolling interests' share of income for 2018 as compared to the 2017 was due to higher profitability from all of our three consolidated subsidiaries in China.

The decrease in noncontrolling interests' share of losses for 2017 as compared to the 2016 was due to higher profitability from two of our three consolidated subsidiaries in China, which was partially offset with lower profitability from our other consolidated subsidiary in China.

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Liquidity and Capital Resources

	Year Ended December 31,		
	2018	2017	2016
	(\$ in thousands)		
Net cash provided by (used in):			
Operating activities	\$ 3,218	\$ 8,615	\$ 12,504
Investing activities	(30,827)	(36,458)	(1,113)
Financing activities	213	35,638	1,298
Effect of exchange rate changes	(430)	405	(1,412)
Net change in cash and cash equivalents	(27,826)	8,200	11,277
Cash and cash equivalents—beginning year	44,352	36,152	24,875
Cash and cash equivalents—end of year	16,526	44,352	36,152
Short and long-term investments—end of year	22,846	32,608	17,571
Total cash, cash equivalents and short-term and long-term investments	\$ 39,372	\$ 76,960	\$ 53,723

We consider cash and cash equivalents, short-term investments and long-term investments as liquid and available for use within two years in our current operations. Short-term investments and long-term investments are comprised of money market accounts, certificates of deposit, corporate bonds and notes, and government securities. Also included in short-term investments is our investment in common stock of Intelligent Epitaxy Technology, Inc. (“IntelliEpi”) and GHI. We began classifying IntelliEpi stock as an available-for-sale security upon its initial public offering in 2013 and sold our remaining IntelliEpi stock in the second quarter of 2015. In 2015, we re-categorized our GHI investment from the cost method to short-term investments when we determined that there was sufficient trading volume in the exchange for the stock to be determined readily marketable. During the three months ended March 31, 2017, we sold the remainder of our GHI stock. As of December 31, 2018, we and our consolidated joint ventures held approximately \$12.4 million in cash and investments in foreign bank accounts. This consists of \$6.6 million held by our wholly owned subsidiary in China and \$5.9 million held by our three partially-owned consolidated subsidiaries in China.

Total cash and cash equivalents, short-term and long-term investments decreased by \$37.6 million in 2018. As of December 31, 2018, our principal source of liquidity was \$39.4 million, which consisted of cash and cash equivalents of \$16.5 million, short-term investments of \$22.1 million and long-term investments of \$0.7 million. In 2018, cash and cash equivalents decreased by \$27.8 million and short-term and long-term investments decreased by \$9.8 million. The decrease in cash and cash equivalents of \$27.8 million in 2018 was primarily due to net cash used in investing activities of \$30.8 million, primarily due to property, plant and equipment activities for the new manufacturing sites in China, and the effect of exchange rate changes of \$0.4 million, and was partially offset by net cash provided by operating activities of \$3.2 million and net cash provided by financing activities of \$0.2 million.

Total cash and cash equivalents, short-term and long-term investments increased by \$23.2 million in 2017. As of December 31, 2017, our principal source of liquidity was \$77.0 million, which consisted of cash and cash equivalents of \$44.4 million, short-term investments of \$20.0 million and long-term investments of \$12.6 million. In 2017, cash and cash equivalents increased by \$8.2 million and short-term and long-term investments increased by \$15.0 million. The increase in cash and cash equivalents of \$8.2 million in 2017 was primarily due to net cash provided by operating activities of \$8.6 million and net cash provided by financing activities of \$35.6 million, primarily due to the net proceeds of \$31.9 million received from the public offering of 5,307,692 shares of our common stock in March 2017, proceeds of \$2.5 million from the exercise of common stock options and proceeds from sales of subsidiary shares to noncontrolling interest of \$1.8 million partially offset by the net dividends paid by

our joint ventures of \$0.5 million, and was partially offset by net cash used in investing activities of \$36.5 million. As of December 31, 2017, we and our consolidated joint ventures held approximately \$21.4 million in cash and investments in foreign bank accounts. This consists of \$11.5 million held by our wholly owned subsidiary in China and \$9.9 million held by our three partially-owned consolidated subsidiaries in China.

Net cash provided by operating activities of \$3.2 million for 2018 was primarily comprised of our net income of \$11.0 million, adjusted for non-cash items of depreciation and amortization of \$4.9 million, stock-based compensation of

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\$1.9 million, loss on equity method investments of \$1.1 million, amortization of marketable securities premium of \$0.2 million offset in part by gain on disposal of property, plant and equipment of \$0.1 million, which were partially offset by a net change of \$15.7 million in operating assets and liabilities. The \$15.7 million net change in operating assets and liabilities primarily resulted from a \$14.6 million increase in inventories, a \$4.6 million increase in prepaid expenses and other current assets, a \$1.9 million increase in other assets, a \$0.3 million decrease in other long-term liabilities offset in part by a \$0.5 million increase in accrued liabilities, a \$2.8 million decrease in accounts receivable, and a \$2.3 million increase in accounts payable.

Net cash provided by operating activities of \$8.6 million for 2017 was primarily comprised of our net income of \$10.1 million, adjusted for non-cash items of depreciation and amortization of \$4.4 million, loss on equity method investments of \$1.4 million, stock-based compensation of \$1.4 million, impairment charge on equity investee of \$0.3 million, amortization of marketable securities premium of \$0.2 million, which were partially offset by a net change of \$9.1 million in operating assets and liabilities. The \$9.1 million net change in operating assets and liabilities primarily resulted from a \$8.0 million increase in accounts receivable, a \$4.7 million increase in inventories, a \$2.3 million increase in prepaid expenses and other current assets, offset in part by a \$4.4 million increase in accounts payable and a \$1.6 million increase in accrued liabilities.

Net cash provided by operating activities of \$12.5 million for 2016 was primarily comprised of our net income of \$5.0 million, an adjustment of non-cash items of depreciation of \$4.9 million, loss on equity method investments of \$2.0 million, stock-based compensation of \$1.1 million, provision for doubtful accounts of \$0.3 million, amortization of marketable securities premium of \$94,000, loss on disposal property and equipment of \$5,000, which were partially offset by realized gain on sales of investments of \$0.4 million and a net change of \$0.4 million in assets and liabilities. The \$0.4 million net change in operating assets and liabilities primarily resulted from a \$3.0 million increase in inventories, a \$1.2 million increase in prepaid expenses and other current assets, a \$0.9 million decrease in other long-term liabilities, offset in part by a \$3.5 million decrease in accounts receivable, a \$0.5 million decrease in other assets, a \$0.5 million increase in accounts payable and a \$0.2 million increase in accrued liabilities.

Net cash used in investing activities of \$30.8 million for 2018 was primarily due to property, plant and equipment of \$40.6 million in preparation for our new manufacturing sites, additional equipment for our Beijing site and equipment and facility costs incurred by our three partially owned subsidiaries and the purchases of marketable investment securities of \$9.9 million, which were partially offset by proceeds from maturities and sales of available-for-sale securities of \$19.6 million and proceeds from sale of property, plant and equipment of \$0.1 million.

Net cash used in investing activities of \$36.5 million for 2017 was primarily from the purchases of marketable investment securities of \$30.0 million and investments in property, plant and equipment of \$21.4 million in preparation for our new manufacturing sites, additional equipment for our Beijing site and equipment and facility costs incurred by our three partially owned subsidiaries, which were partially offset by proceeds from maturities and sales of available-for-sale securities of \$14.8 million.

Net cash used in investing activities of \$1.1 million for 2016 was primarily from the purchases of marketable investment securities of \$11.9 million and the purchase of property, plant and equipment of \$2.7 million, which were partially offset by proceeds from maturities and sales of available-for-sale securities of \$13.5 million.

Net cash provided by financing activities was \$0.2 million for 2018, which mainly consisted of the proceeds of \$0.6 million from the exercise of common stock options, partially offset by the considerations paid in cash to repurchase subsidiary shares from noncontrolling interests of \$0.4 million.

Net cash provided by financing activities was \$35.6 million for 2017, which mainly consisted of the net proceeds of \$31.9 million received from the public offering of 5,307,692 shares of our common stock in March 2017, proceeds of

\$2.5 million from the exercise of common stock options and proceeds from sales of subsidiary shares to noncontrolling interest of \$1.8 million, partially offset by the net dividends paid by our joint ventures of \$0.5 million, which mainly consisted of proceeds from common stock options exercised.

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Net cash provided by financing activities was \$1.3 million for 2016, which mainly consisted of proceeds from common stock options exercised.

On October 27, 2014, our Board of Directors approved a stock repurchase program pursuant to which we may repurchase up to \$5.0 million of our outstanding common stock. These repurchases can be made from time to time in the open market and are funded from our existing cash balances and cash generated from operations. During 2015, we repurchased approximately 908,000 shares at an average price of \$2.52 per share for a total purchase price of approximately \$2.3 million under the stock repurchase program. No shares were repurchased during 2018, 2017 and 2016 under this program. As of December 31, 2018, approximately \$2.7 million remained available for future repurchases under this program. Currently, we do not plan to repurchase additional shares.

Dividends accrue on our outstanding Series A preferred stock, and are payable as and when declared by our board of directors. We have never paid or declared any dividends on the Series A preferred stock. By the terms of the Series A preferred stock, so long as any shares of Series A preferred stock are outstanding, neither the Company nor any subsidiary of the Company shall redeem, repurchase or otherwise acquire any shares of common stock, unless all accrued dividends on the Series A preferred stock have been paid. During 2013 and 2015, we repurchased shares of our outstanding common stock. As of December 31, 2015, the Series A preferred stock had cumulative dividends of \$2.9 million and we included this amount in “Accrued liabilities” in our consolidated balance sheets. At the time we pay this accrued liability, our cash and cash equivalents would be reduced. We account for the cumulative year to date dividends on the Series A preferred stock when calculating our earnings per share. See Item 5, Market for Registrant’s Common Equity, Related Stockholder Matters and Issuer Purchases of Equity Securities in Part II.

The Beijing city government is moving its offices into the area where our original manufacturing facility is currently located and is in the process of moving thousands of government employees into this area. To create room and upgrade the district, the city instructed virtually all existing manufacturing companies, including AXT, to relocate all or some of their manufacturing lines. In 2018, we made significant progress in the relocation of our gallium arsenide and germanium production lines. One new site, the city of Kazuo, located in the province in Liaoning near the Inner Mongolia Autonomous Region, will initially be used for poly synthesis and ingot growth for gallium arsenide and germanium as well as possible expansion of indium phosphide ingot growth. A second site, the city of Dingxing, located in the province of Hebei and under the jurisdiction of the prefecture-level city of Baoding, will be used for wafer processing. We expect to invest approximately \$21 million related to the new facilities in 2019. We intend to complete the relocation process for GaAs and Ge in 2019.

One of our consolidated joint ventures, JinMei, is in the process of relocating its headquarters and manufacturing operations to the city of Kazuo, located in the province in Liaoning near the Inner Mongolia Autonomous Region, very near our own location. Currently, JinMei expects to invest approximately \$2.5 to 3.5 million related to the new facilities in 2019. In July 2017, our wholly-owned subsidiary, Tongmei, provided an inter-company loan to JinMei in the amount of \$768,000 in preparation for the acquisition of the land use rights and the construction of a new building. The inter-company loan carries an interest rate of 4.9% per annum and is due on June 30, 2023. During 2018, JinMei repaid principal and interest totaling \$453,000 to Tongmei. As of December 31, 2018, the remaining balance of principal and interest totaled \$316,000.

We believe that we have adequate cash and investments to meet our operating needs over the next twelve months. If our sales decrease, however, our ability to generate cash from operations will be adversely affected which could adversely affect our future liquidity, require us to use cash at a more rapid rate than expected, and require us to seek

additional capital.

On October 24, 2016, we filed with the SEC a registration statement on Form S-3, pursuant to which we may offer up to \$60 million of common stock, preferred stock, depositary shares, warrants, debt securities and/or units in one or more offerings and in any combination. On November 4, 2016, the SEC declared the registration statement effective. A prospectus supplement, which we will provide each time we offer securities, will describe the specific amounts, prices and terms of the securities we determine to offer.

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On March 2, 2017, we filed with the SEC a final prospectus supplement, pursuant to which we offered and sold 5,307,692 shares of our common stock. The net proceeds are being used for the relocation of our gallium arsenide production line, for equipment capital expenditures, working capital for accounts receivable and inventory, possible acquisitions of complementary products, technologies or businesses and other general purposes.

Cash from operations could be affected by various risks and uncertainties, including, but not limited to those set forth below under Item 1A. “Risk Factors” above.

Bank Loans and Line of Credit

In September 2018, Tongmei entered into a credit facility with Industrial and Commercial Bank of China (“ICBC”) in China with a \$2.9 million line of credit at an annual interest rate of approximately 0.4% over the current Loan Prime Rate published by ICBC. Accrued interest is calculated and paid monthly. The annual interest rate was approximately 4.4%. This credit line was secured by Tongmei’s land-use right and all of its buildings located at its facility in Beijing. The primary intended use of the credit facility was for general purposes, which may include working capital, capital expenditures and other corporate expenses. In September 2018, we borrowed \$291,000 against this credit line. The repayment of the full amount was due in September 2019. However, on December 26, 2018, we repaid the principal of \$291,000 and interest of \$3,000 and terminated this credit line. We decided to terminate this loan because we were able to secure a larger bank loan in the U.S. and our management believed that to secure bank loans in the future based on the two new manufacturing sites may have more strategic advantages as compared to have a loan based on the Beijing site.

On November 6, 2018, the Company entered into a Credit Agreement (the “Credit Agreement”), by and between the Company and Wells Fargo Bank, National Association, which established a \$10 million secured revolving line of credit with a \$1.0 million letter of credit sublimit facility. The revolving credit facility is collateralized by substantially all of the assets of the Company located within the United States, subject to certain exceptions. The commitments under the Credit Agreement expire on November 30, 2020 and any loans thereunder will bear interest at a rate based on the daily one-month London Inter-bank Offered Rate (“LIBOR”) for the applicable interest period plus a margin of 2.00%. As of December 31, 2018, no loans or letters of credit were outstanding under the Credit Agreement.

Off-Balance Sheet Arrangements

We did not have any off-balance sheet financing arrangements and have never established any special purpose entities as defined under SEC Regulation S-K Item 303(a)(4)(ii). We have not entered into any options on non-financial assets.

Contractual Obligations

We lease certain office space, warehouse facilities and equipment under long-term operating leases expiring at various dates through August 2022. The majority of our lease obligations relate to our lease agreement for the facility in Fremont, California with approximately 19,467 square feet. The term of the original lease for this facility would have

expired in 2017. According to the lease agreement, we had an option to extend the term of the lease for an additional three years. In May 2017, we exercised this option and the lease was extended for an additional three year term. All terms of this lease remain the same and the term of this lease will expire in 2020 at which point we have an option to extend an additional three years. Total rent expenses under these operating leases were approximately \$319,000, \$302,000 and \$331,000 for the years ended December 31, 2018, 2017 and 2016, respectively.

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We entered into a royalty agreement with Sumitomo effective December 3, 2010 with a term of eight years, terminating December 31, 2018. We and our related companies were granted a worldwide, nonexclusive, royalty bearing, irrevocable license to certain patents for the term on the agreement. Under this agreement we could have paid up to \$7.0 million in royalty payments over eight years beginning in 2011 based on future royalty bearing sales. This agreement contained a clause that allowed us to claim a credit, starting in 2013, in the event that the royalty bearing sales for the year is lower than a pre-determined amount set forth in this agreement. For the year ended December 31, 2018, royalty expense under this agreement was \$565,000, which was net of claim for credit of \$10,000. Royalty expense for the year ended December 31, 2017 was \$526,000, which was net of claim for credit of \$49,000. Royalty expense for the year ended December 31, 2016 was \$447,000, which was net of claim for credit of \$128,000. Sumitomo has asked that we renew this license and the need to do so is under review.

The following table summarizes our contractual obligations as of December 31, 2017 (in thousands):

Contractual Obligations	Payments due by period				
	Total	Less than 1 year	1-3 years	4-5 years	More than 5 years
Operating leases	\$ 374	\$ 198	\$ 170	\$ 6	\$ —

Land Purchase and Investment Agreement

We are in the process of relocating our gallium arsenide production line to Dingxing, China. In addition to a land rights and building purchase agreement that we entered into with a private real estate development company to acquire our new manufacturing facility, we also entered into a cooperation agreement with the Dingxing local government. In addition to pledging its full support and cooperation, the Dingxing local government will issue certain credits or rebates to us as we achieve certain milestones. We, in turn, agreed to hire local workers over time, pay taxes when due and eventually demonstrate a total investment of approximately \$90 million in value, assets and capital. The investment will include cash paid for the land and buildings, cash on deposit in our name at local banks, the gross value of new and used equipment (including future equipment that might be used for indium phosphide and germanium substrates production), the deemed value for our customer list or the end user of our substrates (for example, the end users of the 3-D sensing VCSELs), a deemed value for employment of local citizens, a deemed value for our proprietary process technology, other intellectual property, other intangibles and additional items of value. There is no timeline or deadline by which this must be accomplished, rather it is a good faith covenant entered into between AXT and the Dingxing local government. Further, there is no specific penalty contemplated if either party breaches the agreement, however the agreement does state that each party has a right to seek from the other party compensation for losses. Under certain conditions, the Dingxing local government may purchase the land and building at the appraised value. We believe that such cooperation agreements are normal, customary and usual in China and that the future valuation is flexible. We have a similar agreement with the city of Kazuo, China, although on a smaller scale. The total investment targeted by AXT in Kazuo is approximately \$15 million in value, assets and capital.

Purchase Obligations with Penalties for Cancellation

In the normal course of business, we issue purchase orders to various suppliers. In certain cases, we may incur a penalty if we cancel the purchase order. As of December 31, 2018, we do not have any outstanding purchase orders that will incur a penalty if cancelled by the Company.

Selected Quarterly Results of Operations

The following table sets forth unaudited quarterly results for the eight quarters ended December 31, 2018. The information for each of these quarters is unaudited but has been prepared on the same basis as the audited consolidated financial statements. We believe that all necessary adjustments, consisting only of normal recurring adjustments, have been included in the amounts stated below to present fairly such quarterly information. The operating results for any quarter are not necessarily indicative of results for any subsequent period.

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(in thousands, except for per share amounts)	Quarters Ended							
	Dec. 31, 2018	Sept. 30, 2018	June 30, 2018	Mar. 31, 2018	Dec. 31, 2017	Sept. 30, 2017	June 30, 2017	Mar. 31, 2017
Revenue	\$ 22,232	\$ 28,626	\$ 27,120	\$ 24,419	\$ 26,332	\$ 28,168	\$ 23,557	\$ 20,616
Cost of revenue	16,382	18,012	16,110	14,846	16,534	17,035	16,301	14,328
Gross profit	5,850	10,614	11,010	9,573	9,798	11,133	7,256	6,288
Operating expenses:								
Selling, general and administrative	5,179	4,615	4,987	4,222	4,790	4,484	3,942	3,793
Research and development	1,309	1,668	1,500	1,420	1,274	1,410	1,019	1,124
Total operating expenses	6,488	6,283	6,487	5,642	6,064	5,894	4,961	4,917
Income (loss) from operations	(638)	4,331	4,523	3,931	3,734	5,239	2,295	1,371
Interest income, net	114	133	139	142	127	122	114	98
Equity in earnings (loss) of unconsolidated joint ventures	(1,059)	6	307	(334)	(307)	(266)	(188)	(933)
Other (expense) income, net	531	87	(51)	(215)	(150)	(349)	(102)	48
Income (loss) before provision for income taxes	(1,052)	4,557	4,918	3,524	3,404	4,746	2,119	584
Provision for (benefits from) income taxes	(173)	410	367	334	131	181	321	159
Net income (loss)	(879)	4,147	4,551	3,190	3,273	4,565	1,798	425
Less: Net (income) loss attributable to noncontrolling interests	(182)	(208)	(650)	(315)	(139)	(146)	132	240
Net income (loss) attributable to AXT, Inc	\$ (1,061)	\$ 3,939	\$ 3,901	\$ 2,875	\$ 3,134	\$ 4,419	\$ 1,930	\$ 665
Net income (loss) attributable to AXT, Inc. per common share:								
Basic	\$ (0.03)	\$ 0.10	\$ 0.10	\$ 0.07	\$ 0.08	\$ 0.11	\$ 0.05	\$ 0.02
Diluted	\$ (0.03)	\$ 0.10	\$ 0.10	\$ 0.07	\$ 0.08	\$ 0.11	\$ 0.05	\$ 0.02
Weighted average number of common shares outstanding:								
Basic	39,197	39,008	39,001	38,941	38,766	38,499	38,306	34,210
Diluted	39,197	40,331	40,216	40,364	40,448	40,095	39,706	35,624

Recent Accounting Pronouncements

Recent accounting pronouncements are detailed in Note 1 to our Consolidated Financial Statements included in this Annual Report on Form 10-K.

Item 7A. Quantitative and Qualitative Disclosures about Market Risk

Foreign Currency Risk

A significant portion of our business is conducted in currencies other than the U.S. dollar. Foreign exchange losses have had a material adverse effect on our operating results and cash flows in the past and could have a material adverse effect on our operating results and cash flows in the future. If we do not effectively manage the risks associated

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with this currency risk, our revenue, cash flows and financial condition could be adversely affected. Although during 2018 and 2016, we recorded a foreign exchange gain of \$165,000 and \$232,000, respectively, during 2017 we recorded net foreign exchange loss of \$602,000, included as part of other (expense) income, net in our consolidated statements of operation. We incur foreign currency transaction exchange gains and losses due to operations in general. In the future we may experience foreign exchange losses on our non-functional currency denominated receivables and payables to the extent that we have not mitigated our exposure. Foreign exchange losses could have a materially adverse effect on our operating results and cash flows.

Our product sales to Japanese customers are typically invoiced in Japanese yen. As such we have foreign exchange exposure on our accounts receivable and on any Japanese yen denominated cash deposits. To partially protect us against fluctuations in foreign currency resulting from accounts receivable in Japanese yen, starting in 2015, we instituted a foreign currency hedging program. We place short term hedges that are intended to offset the potential cash exposure related to fluctuations in the exchange rate between the United States dollar and Japanese yen. We measure the fair value of these hedges at each month end and quarter end using current exchange rates and in accordance with generally accepted accounting principles. At quarter end and year end any foreign currency hedges not settled are netted on the condensed consolidated balance sheet and consolidated balance sheet, respectively, and classified as Level 3 assets and liabilities. As of December 31, 2018 the net change in fair value from the placement of the hedge to settlement at each month end during the quarter had a de minimis impact to the consolidated results.

The functional currency for our foreign operations is the renminbi, the local currency of China, and in the future we may establish short term hedges covering renminbi. Most of our operations are conducted in China and most of our costs are incurred in Chinese renminbi, which subjects us to fluctuations in the exchange rates between the U.S. dollar and the Chinese renminbi. We incur transaction gains or losses resulting from consolidation of expenses incurred in local currencies for our Chinese subsidiaries, as well as in translation of the assets and liabilities at each balance sheet date. Our financial results could be adversely affected by factors such as changes in foreign currency exchange rates or weak economic conditions in foreign markets, including the revaluation by China of the renminbi, and any future adjustments that China may make to its currency such as any move it might make to a managed float system with opportunistic interventions. We may also experience foreign exchange losses on our non-functional currency denominated receivables and payables.

We currently are using a hedging program to minimize the effects of currency fluctuations relating to the Japanese yen. While we may apply this program to other currencies, such as the Chinese renminbi, our hedging position is partial and may not exist at all in the future. It may not succeed in minimizing our foreign currency fluctuation risks. Our primary objective in holding these instruments is to reduce the volatility of earnings and cash flows associated with changes in foreign currency. The program is not designated for trading or speculative purposes. The company may choose not to hedge certain foreign exchange exposures for a variety of reasons, including but not limited to accounting considerations and the prohibitive economic cost of hedging particular exposures. However, even with our hedging program, we still experience losses on foreign exchange from time to time.

Interest Rate Risk

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Cash and cash equivalents earning interest and certain variable rate debt instruments are subject to interest rate fluctuations. The following table sets forth the probable impact of a 10% change in interest rates (in thousands):

Instrument	Balance as of December 31, 2018	Current Interest Rate		Projected Annual Interest Income	Proforma 10% Interest Rate Decline Income	Proforma 10% Interest Rate Increase Income
Cash and cash equivalents	\$ 16,526	0.22	%	\$ 36	\$ 32	\$ 40
Investments in marketable debt	22,846	2.46	%	562	506	618
				\$ 598	\$ 538	\$ 658

The primary objective of our investment activities is to preserve principal while maximizing income without significantly increasing risk. Financial instruments that potentially subject us to concentration of credit risk consist

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primarily of cash and cash equivalents, short-term investments, and trade accounts receivable. We invest primarily in money market accounts, certificates of deposit, corporate bonds and notes, and government securities. We are exposed to credit risks in the event of default by the issuers to the extent of the amount recorded on the consolidated balance sheets. These securities are generally classified as available-for-sale and consequently are recorded on the balance sheet at fair value with unrealized gains or losses reported as a separate component of accumulated other comprehensive income, net of estimated tax. Our cash, cash equivalents and short-term investments and long-term investments are in high-quality securities placed with major banks and financial institutions and commercial paper. We have no investments in auction rate securities.

Credit Risk

We perform ongoing credit evaluations of our customers' financial condition, and limit the amount of credit extended when deemed necessary, but generally do not require collateral. The credit risk in our accounts receivable is mitigated by our credit evaluation process and the geographical dispersion of sales transactions. Three customers accounted for 17%, 12% and 10% of our trade accounts receivable as of December 31, 2018 and one customer accounted for 12% of our trade accounts receivable as of December 31, 2017.

Equity Risk

As part of our supply chain strategy, we maintain minority investments in privately-held companies located in China either invested directly by us and our wholly-own subsidiary or indirectly through our three consolidated joint venture companies. These minority investments are reviewed for other than temporary declines in value on a quarterly basis. These investments are classified as other assets in the consolidated balance sheets and accounted for under either the equity or cost method, depending on whether we have the ability to exercise significant influence over their operations or financial decisions. We monitor our investments for impairment and record reductions in carrying value when events or changes in circumstances indicate that the carrying value may not be recoverable. Reasons for other than temporary declines in value include whether the related company would have insufficient cash flow to operate for the next twelve months, significant changes in the operating performance and changes in market conditions. As of December 31, 2018 and 2017, we did not maintain any direct investments under the cost method. Our direct minority investments under the equity method totaled \$4.0 million and \$5.6 million, respectively, and our indirect minority investments through our consolidated joint ventures totaled \$4.5 million and \$4.3 million, respectively. In aggregate, as of December 31, 2018 and 2017 the total of our direct and indirect investments in the seven companies under the equity method totaled \$8.4 million and \$9.8 million, respectively.

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Item 8. Consolidated Financial Statements and Supplementary Data

The consolidated financial statements, related notes thereto and financial statement schedules required by this item are listed and set forth beginning on page 70, and are incorporated by reference here. Supplementary financial information regarding quarterly financial information required by this item is set forth under the caption “Selected Quarterly Results of Operations” in Item 7, “Management’s Discussion and Analysis of Financial Condition and Results of Operations,” and is incorporated by reference here.

Item 9. Changes in and Disagreements with Accountants on Accounting and Financial Disclosure

None.

Item 9A. Controls and Procedures

Evaluation of Disclosure Controls and Procedures

Our management, with the participation of our Chief Executive Officer and our Chief Financial Officer, evaluated the effectiveness of the design and operation of our disclosure controls and procedures as of the end of the period covered by this Annual Report on Form 10-K. Based upon this evaluation, our Chief Executive Officer and Chief Financial Officer have concluded that our disclosure controls and procedures as defined under Exchange Act Rules 13a-15(e) and 15d-15(e) were effective at the reasonable assurance level to ensure that information required to be disclosed in our Securities Exchange Act reports is recorded, processed, summarized and reported within the time periods specified by the Securities and Exchange Commission and is accumulated and communicated to management, including our Chief Executive Officer and our Chief Financial Officer, as appropriate to allow timely decisions regarding required disclosure.

Our disclosure controls and procedures include components of our internal control over financial reporting. Management’s assessment of the effectiveness of our internal control over financial reporting is expressed at the level of reasonable assurance because a control system, no matter how well designed and operated, can provide only reasonable assurance that the control system’s objectives will be met.

Management’s Report on Internal Control over Financial Reporting

Our management is responsible for establishing and maintaining adequate internal control over financial reporting, as such term is defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act. Internal control over financial reporting is a process designed by, or under the supervision of, our Chief Executive Officer and Chief Financial Officer, and implemented by our 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 accounting principles generally accepted in the United States of America (“U.S. GAAP”). 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 our transactions and dispositions of our assets;
- provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with U.S. GAAP, and that receipts and expenditures are being made only in accordance with authorizations of our management and directors; and
- provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use or disposition of our assets that could have a material effect on the consolidated financial statements.

Because of 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

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may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

Our management, under the supervision and with the participation of our Chief Executive Officer and Chief Financial Officer, has assessed the effectiveness of our internal control over financial reporting as of December 31, 2018 based on the criteria established in Internal Control—Integrated Framework (2013) issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO). Management has concluded that our internal control over financial reporting was effective as of December 31, 2018.

Our independent registered public accounting firm, BPM LLP, has audited the consolidated financial statements included in this Annual Report on Form 10-K and has issued its report on the effectiveness of our internal control over financial reporting as of December 31, 2018.

Changes in Internal Control over Financial Reporting

Beginning December 31, 2017, we implemented ASC 606, Revenue from Contracts with Customers. We implemented changes to our processes related to revenue recognition and the control activities within them. These included the development of new policies based on the five-step model provided in the new revenue standard, ongoing contract review requirements, and gathering of information provided for disclosures.

There was no change in our internal control over financial reporting during our fourth quarter of fiscal 2018 that has materially affected, or is reasonably likely to materially affect, AXT's internal control over financial reporting.

Item 9B. Other Information

None.

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Report of Independent Registered Public Accounting Firm

To the Board of Directors and Stockholders of AXT, Inc.

Opinion on Internal Control over Financial Reporting

We have audited the internal control over financial reporting of AXT, Inc. and its subsidiaries (the “Company”) as of December 31, 2018, based on criteria established in Internal Control—Integrated Framework (2013) issued by the Committee of Sponsoring Organizations of the Treadway Commission (the “COSO criteria”). In our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2018, based on the COSO criteria.

We also have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) (“PCAOB”), the consolidated balance sheets as of December 31, 2018 and 2017 and the related consolidated statements of operations, comprehensive income, stockholders’ equity, and cash flows for each of the three years in the period ended December 31, 2018, and the related notes (collectively referred to as the “consolidated financial statements”) of the Company, and our report dated March 11, 2019, expressed an unqualified opinion on those consolidated financial statements.

Basis for Opinion

The Company’s management is responsible 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 Controls over Financial Reporting. Our responsibility is to express an opinion on the Company’s internal control over financial reporting based on our audit. We are a public accounting firm registered with the 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 audit in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether effective internal control over financial reporting was maintained in all material respects. 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 audit also included performing such other procedures as we considered necessary in the circumstances. We believe that our audit provides a reasonable basis for our opinion.

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/ BPM LLP

San Jose, California

March 11, 2019

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PART III

The United States Securities and Exchange Commission (“SEC”) allows us to include information required in this report by referring to other documents or reports we have already or will soon be filing. This is called “Incorporation by Reference.” We intend to file our definitive proxy statement for our annual meeting of stockholders to be held on May 23, 2019 (the “Proxy Statement”) pursuant to Regulation 14A not later than 120 days after the end of the fiscal year covered by this report, and certain information therein is incorporated in this report by reference.

Item 10. Directors, Executive Officers and Corporate Governance

The information required by this item with respect to identification of directors is incorporated by reference to the information contained in the section captioned “Information About our Board of Directors” in the Proxy Statement. The information with respect to our executive officers, is incorporated by reference to the information contained in the section captioned “Executive Officers” in the Proxy Statement. Information with respect to Items 405 of Regulation S-K is incorporated by reference to the information contained in the sections of the Proxy Statement captioned “Section 16(a) Beneficial Ownership Reporting Compliance.” There will be no disclosure under Item 407(c)(3). Information with respect to Items 407(d)(4) and 407(d)(5) is incorporated by reference to the information contained in the sections of the Proxy Statement captioned “Corporate Governance—Committees of the Board of Directors.”

The Board of Directors of AXT, Inc. has adopted a Code of Conduct and Ethics (the “Code”) that applies to our principal executive officers, principal financial officer, and corporate controller, as well as other employees. A copy of this Code has been posted on our Internet website at www.axt.com. Any amendments to, or waivers from, a provision of our Code that applies to our principal executive officer, principal financial officer, controller, or persons performing similar functions and that relates to any element of the Code enumerated in paragraph (b) of Item 406 of Regulation S-K shall be disclosed by posting such information on our website.

Item 11. Executive Compensation

The information required by this Item is incorporated herein by reference to information set forth in our Proxy Statement under the section entitled “Executive Compensation and Other Matters.”

Item 12. Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters

The information required by this Item is incorporated herein by reference to information set forth in our Proxy Statement under the section entitled “Security Ownership of Certain Beneficial Owners and Management” and “Equity Compensation Plan Information.”

Item 13. Certain Relationships and Related Transactions and Director Independence

Information required by this item will be set forth in our Proxy Statement under the headings “Compensation Committee Interlocks and Insider Participation” and “Certain Relationships and Related Transactions,” which information is incorporated herein by reference.

Item 14. Principal Accountant Fees and Services

The information required by this Item is incorporated herein by reference to information set forth in our Proxy Statement under the section entitled “Ratification of Appointment of Independent Registered Public Accountants.”

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PART IV

Item 15. Exhibits and Financial Statement Schedules

(a)The following documents are filed as part of this report:

(1)Financial Statements:

INDEX TO CONSOLIDATED FINANCIAL STATEMENTS

<u>Report of Independent Registered Public Accounting Firm</u>	64
<u>Consolidated Balance Sheets</u>	65
<u>Consolidated Statements of Operations</u>	66
<u>Consolidated Statements of Comprehensive Income</u>	67
<u>Consolidated Statements of Stockholders' Equity</u>	68
<u>Consolidated Statements of Cash Flows</u>	69
<u>Notes to Consolidated Financial Statements</u>	70

(2)Financial Statement Schedules

All schedules have been omitted because the required information is not applicable or because the information required is included in the consolidated financial statements or notes thereto.

(b)Exhibits

See Index to Exhibits attached elsewhere to this Form 10-K. The exhibits listed in the accompanying Index to Exhibits are filed as part of, or incorporated by reference into, this report on Form 10-K.

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Report of Independent Registered Public Accounting Firm

To the Board of Directors and Stockholders of AXT, Inc.

Opinion on the Financial Statements

We have audited the accompanying consolidated balance sheets of AXT, Inc. (a Delaware corporation) and its subsidiaries (the “Company”) as of December 31, 2018 and 2017, and the related consolidated statements of operations, comprehensive income, stockholders’ equity, and cash flows for each of the three years in the period ended December 31, 2018, and the related notes (collectively referred to as the “consolidated financial statements”). In our opinion, the consolidated financial statements present fairly, in all material respects, the financial position of the Company as of December 31, 2018 and 2017, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 2018, in conformity with accounting principles generally accepted in the United States of America.

We also have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) (“PCAOB”), the Company’s internal control over financial reporting as of December 31, 2018, based on criteria established in Internal Control—Integrated Framework (2013) issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO), and our report dated March 11, 2019, expressed an unqualified opinion.

Basis for Opinion

These consolidated financial statements are the responsibility of the Company’s management. Our responsibility is to express an opinion on the Company’s consolidated financial statements based on our audits. We are a public accounting firm registered with the 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 audit to obtain reasonable assurance about whether the consolidated financial statements are free of material misstatement, whether due to error or fraud. Our audits 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. We believe that our audits provide a reasonable basis for our opinion.

/s/ BPM LLP

We have served as the Company's auditor since 2004.

San Jose, California

March 11, 2019

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AXT, INC.

CONSOLIDATED BALANCE SHEETS

(In thousands, except per share data)

	December 31,	
	2018	2017
ASSETS		
Current assets:		
Cash and cash equivalents	\$ 16,526	\$ 44,352
Short-term investments	22,129	20,032
Accounts receivable, net of allowances of \$358 and \$527 as of December 31, 2018 and December 31, 2017	19,586	22,778
Inventories	58,571	45,840
Prepaid expenses and other current assets	11,728	7,519
Total current assets	128,540	140,521
Long-term investments	717	12,576
Property, plant and equipment, net	82,280	46,530
Other assets	11,987	11,573
Total assets	\$ 223,524	\$ 211,200
LIABILITIES AND STOCKHOLDERS' EQUITY		
Current liabilities:		
Accounts payable	\$ 13,338	\$ 11,445
Accrued liabilities	15,371	11,149
Total current liabilities	28,709	22,594
Other long-term liabilities	283	289
Total liabilities	28,992	22,883
Commitments and contingencies (Note 16)		
Stockholders' equity:		
Preferred stock Series A, \$0.001 par value; 2,000 shares authorized; 883 shares issued and outstanding as of December 31, 2018 and December 31, 2017 (Liquidation preference of \$6,992 and \$6,815 as of December 31, 2018 and December 31, 2017)	3,532	3,532
Common stock, \$0.001 par value; 70,000 shares authorized; 39,985 and 39,413 shares issued and outstanding as of December 31, 2018 and December 31, 2017	39	39
Additional paid-in capital	234,419	231,679
Accumulated deficit	(45,183)	(54,837)
Accumulated other comprehensive income (loss)	(1,972)	3,407
Total AXT, Inc. stockholders' equity	190,835	183,820
Noncontrolling interests	3,697	4,497
Total stockholders' equity	194,532	188,317
Total liabilities and stockholders' equity	\$ 223,524	\$ 211,200

See accompanying notes to consolidated financial statements.

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AXT, INC.

CONSOLIDATED STATEMENTS OF OPERATIONS

(In thousands, except per share data)

	Year Ended December 31,		
	2018	2017	2016
Revenue	\$ 102,397	\$ 98,673	\$ 81,349
Cost of revenue	65,350	64,198	54,968
Gross profit	37,047	34,475	26,381
Operating expenses:			
Selling, general and administrative	19,003	17,009	13,880
Research and development	5,897	4,827	5,850
Restructuring charge	—	—	226
Total operating expenses	24,900	21,836	19,956
Income from operations	12,147	12,639	6,425
Interest income, net	528	461	409
Equity in loss of unconsolidated joint ventures	(1,080)	(1,694)	(1,995)
Other income (expense), net	352	(553)	860
Income before provision for income taxes	11,947	10,853	5,699
Provision for income taxes	938	792	733
Net income	11,009	10,061	4,966
Less: Net loss (income) attributable to noncontrolling interests	(1,355)	87	670
Net income attributable to AXT, Inc.	\$ 9,654	\$ 10,148	\$ 5,636
Net income attributable to AXT, Inc. per common share:			
Basic	\$ 0.24	\$ 0.27	\$ 0.17
Diluted	\$ 0.24	\$ 0.26	\$ 0.17
Weighted-average number of common shares outstanding:			
Basic	39,049	37,444	32,139
Diluted	40,265	38,966	32,894

See accompanying notes to consolidated financial statements.

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AXT, INC.

CONSOLIDATED STATEMENTS OF COMPREHENSIVE INCOME

(In thousands)

	Year Ended December 31,		
	2018	2017	2016
Net income	\$ 11,009	\$ 10,061	\$ 4,966
Other comprehensive income (loss), net of tax:			
Change in foreign currency translation gain (loss), net of tax	(5,749)	3,726	(4,305)
Change in unrealized gain (loss) on available-for-sale investments, net of tax	9	(138)	(312)
Total other comprehensive income (loss), net of tax	(5,740)	3,588	(4,617)
Comprehensive income	5,269	13,649	349
Less: Comprehensive loss (income) attributable to noncontrolling interests	(994)	(347)	1,158
Comprehensive income attributable to AXT, Inc.	\$ 4,275	\$ 13,302	\$ 1,507

See accompanying notes to consolidated financial statements.

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AXT, INC.

CONSOLIDATED STATEMENTS OF STOCKHOLDERS' EQUITY

(In thousands)

	Preferred Stock		Common Stock		Additional Paid-In Capital	Accumulated Deficit	Accumulated Other Comprehensive Income (Loss)	AXT, Inc. Stockholders' Equity	Noncontrolling Interests	Total Stockholders' Equity
	Shares	\$	Shares	\$						
2016	\$ 883	\$ 3,532	\$ 32,548	\$ 32	\$ 191,745	\$ (70,621)	\$ 4,382	\$ 129,070	\$ 5,590	\$
stock exercised			555	1	1,336			1,337		
stock canceled			(207)					—		
redemption					1,096			1,096		
conversion of										
the form of stock			136					—		
and						5,636		5,636	(670)	
joint								—	(52)	
comprehensive loss							(4,129)	(4,129)	(488)	
of										
31, 2016	883	3,532	33,032	33	194,177	(64,985)	253	133,010	4,380	
stock exercised			762	1	2,476			2,477		
subsidiary										
selling					1,765			1,765	235	
redemption					1,405			1,405		
conversion of										
the form of stock			312					—		
of										
stock, net										
issuance										
2016			5,307	5	31,856			31,861		

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AXT, INC.

CONSOLIDATED STATEMENTS OF CASH FLOWS

	Year Ended December 31,		
	2018	2017	2016
Cash flows from operating activities:			
Net income	\$ 11,009	\$ 10,061	\$ 4,966
Adjustments to reconcile net income to net cash provided by operating activities:			
Depreciation and amortization	4,871	4,422	4,865
Amortization of marketable securities premium	158	173	94
Impairment charge on equity investee	—	313	—
Stock-based compensation	1,925	1,405	1,096
Provision for doubtful accounts	—	—	313
Realized gain on sale of available-for-sale securities	—	(77)	(429)
Loss (gain) on disposal of equipment	(99)	57	5
Loss from equity method investments, net	1,080	1,381	1,995
Changes in operating assets and liabilities:			
Accounts receivable	2,819	(7,977)	3,465
Inventories	(14,629)	(4,740)	(2,959)
Prepaid expenses and other current	(4,600)	(2,309)	(1,223)

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assets			
Other assets	(1,888)	(52)	458
Accounts payable	2,314	4,401	524
Accrued liabilities	* 518	1,642	205
Other long-term liabilities, including royalties	(260)	(85)	(871)
Net cash provided by operating activities	3,218	8,615	12,504
Cash flows from investing activities:			
Purchases of property, plant and equipment	(40,539)	(21,356)	(2,728)
Proceeds from sale of equipment	99	—	35
Purchases of available-for-sale securities	(9,937)	(30,021)	(11,936)
Proceeds from sales and maturities of available-for-sale securities	19,550	14,750	13,516
Repayment of related party notes receivable	—	169	—
Net cash used in investing activities	(30,827)	(36,458)	(1,113)
Cash flows from financing activities:			
Proceeds from issuance of common stock and options exercised, net of issuance costs	628	34,338	1,337
Proceeds from sale of subsidiary shares to noncontrolling interests, net of portion allocated to noncontrolling interests	—	1,765	—

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Considerations paid in cash to repurchase subsidiary shares from noncontrolling interests	(415)	—	—
Dividends paid by joint ventures to their minority shareholders	—	(465)	(39)
Net cash provided by financing activities	213	35,638	1,298
Effect of exchange rate changes on cash and cash equivalents	(430)	405	(1,412)
Net (decrease) increase in cash and cash equivalents	(27,826)	8,200	11,277
Cash and cash equivalents at the beginning of the year	44,352	36,152	24,875
Cash and cash equivalents at the end of the year	\$ 16,526	\$ 44,352	\$ 36,152
Supplemental disclosures:			
Income taxes paid, net of refunds	\$ 1,134	\$ 714	\$ 788
Supplemental disclosure of non-cash flow information:			
Consideration payable to repurchase subsidiary shares from noncontrolling interests, included in accrued liabilities	\$ 1,192	\$ —	\$ —
Reduction of noncontrolling interests in excess	\$ 187	\$ —	\$ —

of total
 consideration
 paid and payable
 in connection
 with the
 repurchase of
 subsidiaries
 shares from
 noncontrolling
 interests
 Consideration
 payable in
 connection with
 constructions,
 included in
 accrued liabilities \$ 2,912 \$ — \$ —

* Dividend accrued but not paid by joint ventures of \$504, \$533 and \$499 was included in accrued liabilities as of December 31, 2018, 2017 and 2016, respectively.

See accompanying notes to consolidated financial statements.

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AXT, INC.

NOTES TO CONSOLIDATED FINANCIAL STATEMENTS

Note 1. The Company and Summary of Significant Accounting Policies

The Company

AXT, Inc. (“AXT”, “the Company”, “we,” “us,” and “our” refer to AXT, Inc. and its consolidated subsidiaries) is a worldwide materials science company that develops and produces high-performance compound and single element semiconductor substrates, also known as wafers. Our consolidated subsidiaries produce and sell certain raw materials some of which are used in our substrate manufacturing process and some of which are sold to other companies.

Our substrate wafers are used when a typical silicon substrate wafer cannot meet the conductive requirements of a semiconductor or optoelectronic device. The dominant substrates used in producing semiconductor chips and other electronic circuits are made from silicon. However, certain chips may become too hot or perform their function too slowly if silicon is used as the base material. In addition, optoelectronic applications, such as LED lighting and chip-based lasers, do not use silicon substrates because they require a wave form frequency that cannot be achieved using silicon. Alternative or specialty materials are used to replace silicon as the preferred base in these situations. Our wafers provide such alternative or specialty materials. We do not design or manufacture the chips. We add value by researching, developing and producing the specialty material wafers. We have two product lines: specialty material substrates and raw materials integral to these substrates. In 2018, our substrate product group generated 79% of our revenue and raw materials product group generated 21%. Our compound substrates combine indium with phosphorous (indium phosphide: InP) or gallium with arsenic (gallium arsenide: GaAs). Our single element substrates are made from germanium (Ge).

Our raw materials include both raw gallium and purified gallium. We use purified gallium in producing our GaAs substrates and sell both raw gallium and purified gallium in the open market to other companies for use in magnetic materials, high temperature thermometers and growing single crystal ingots including gallium arsenide, gallium nitride, gallium antimonide, gallium phosphide and other materials and alloys. We also produce pyrolytic boron nitride (pBN) crucibles used in the high temperature (typically in the range 500 C to 1,500 C) growth process of single crystal ingots and epitaxial layer growth in MBE reactors. We use these pBN crucibles in our own ingot growth processes and also sell them in the open market to other companies.

Principles of Consolidation

The consolidated financial statements include the accounts of AXT, our wholly-owned subsidiary, Beijing Tongmei Xtal Technology Co., Ltd., and our majority-owned, or significantly controlled subsidiaries, Beijing JiYa Semiconductor Material Co., Ltd., Nanjing JinMei Gallium Co., Ltd. and Beijing BoYu Semiconductor Vessel Craftwork Technology Co., Ltd. All significant inter company accounts and transactions have been eliminated. Investments in business entities in which we do not have controlling interest, but have the ability to exercise significant influence over operating and financial policies (generally 20-50% ownership), are accounted for by the equity method. We have seven companies accounted for by the equity method. For subsidiaries that we consolidate, we reflect the portion we do not own on our consolidated balance sheets in stockholders' equity and in our consolidated statements of operations.

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Use of Estimates

The preparation of financial statements in conformity with accounting principles generally accepted in the United States of America ("U.S. GAAP") requires management to make estimates, judgments and assumptions. We believe that the estimates, judgments, and assumptions upon which management relies are reasonable based on information available at the time that these estimates, judgments, and assumptions are made. These estimates, judgments, and assumptions can affect the reported amounts of assets and liabilities as of the date of the consolidated financial statements as well as the reported amounts of revenues and expenses during the periods presented. To the extent there are material differences between these estimates and actual results, our consolidated financial statements would be affected.

Fair Value of Financial Instruments

The carrying amounts of certain of our financial instruments including cash and cash equivalents, short-term investments and long-term investments, accounts receivable, accounts payable and accrued liabilities approximate fair value due to their short maturities. Certain cash equivalents and investments are required to be adjusted to fair value on a recurring basis. See Note 2.

Fair Value of Investments

Accounting Standards Codification ("ASC") topic 820, Fair value measurement ("ASC 820") establishes three levels of inputs that may be used to measure fair value.

Level 1 instruments represent quoted prices in active markets. Therefore, determining fair value for Level 1 instruments does not require significant management judgment, and the estimation is not difficult.

Level 2 instruments include observable inputs other than Level 1 prices, such as quoted prices for similar instruments in markets with insufficient volume or infrequent transactions (less active markets), issuer bank statements, credit ratings, non-binding market consensus prices that can be corroborated with observable market data, model-derived valuations in which all significant inputs are observable or can be derived principally from or corroborated with observable market data for substantially the full term of the assets or liabilities, or quoted prices for similar assets or liabilities. These Level 2 instruments require more management judgment and subjectivity compared to Level 1 instruments, including:

- Determining which instruments are most comparable to the instrument being priced requires management to identify a sample of similar securities based on the coupon rates, maturity, issuer, credit rating, and instrument type, and subjectively select an individual security or multiple securities that are deemed most similar to the security being priced.
- Determining which model-derived valuations to use in determining fair value requires management judgment. When observable market prices for similar securities or comparable securities are not available, we price our marketable debt instruments using non-binding market consensus prices that are corroborated with observable market data or pricing models, such as discounted cash flow models, with all significant inputs derived from or corroborated with observable market data.

Level 3 instruments include unobservable inputs to the valuation methodology that are significant to the measurement of fair value of assets or liabilities. The determination of fair value for Level 3 instruments requires the most management judgment and subjectivity.

We place short-term foreign currency hedges that are intended to offset the potential cash exposure related to fluctuations in the exchange rate between the United States dollar and Japanese yen. We measure the fair value of

these foreign currency hedges at each month end and quarter end using current exchange rates and in accordance with generally accepted accounting principles. At quarter end any foreign currency hedges not settled are netted in “Accrued liabilities” on the consolidated balance sheets and classified as Level 3 assets and liabilities. As of December 31, 2018

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and 2017, the net change in fair value from the placement of the hedge to settlement had a de minimis impact to the consolidated results.

Foreign Currency Translation

The functional currency of our Chinese subsidiaries is the renminbi, the local currency of China. Transaction gains and losses resulting from transactions denominated in currencies other than the U.S. dollar or in the functional currencies of our subsidiaries are included in "Other (expense) income, net" for the years presented. The transaction gain for the year ended December 31, 2018 totaled \$165,000 whereas the transaction loss for the year ended December 31, 2017 totaled \$602,000. The transaction gain totaled \$232,000 for the year ended December 31, 2016.

The assets and liabilities of the subsidiaries are translated at the rates of exchange on the balance sheet date. Revenue and expense items are translated at the average rate of exchange for the period. Gains and losses from foreign currency translation are included in "Other comprehensive income (loss)" in the consolidated statements of comprehensive income, net of tax.

Revenue Recognition

We manufacture and sell high-performance compound semiconductor substrates including indium phosphide, gallium arsenide and germanium wafers, and our three consolidated subsidiaries sell certain raw materials, including 99.99% pure gallium (4N Ga), high purity gallium (7N Ga), pyrolytic boron nitride (pBN) crucibles and boron oxide (B₂O₃). After we ship our products, there are no remaining obligations or customer acceptance requirements that would preclude revenue recognition. Our products are typically sold pursuant to purchase orders placed by our customers, and our terms and conditions of sale do not require customer acceptance. We account for a contract with a customer when there is a legally enforceable contract, which could be the customer's purchase order, the rights of the parties are identified, the contract has commercial terms, and collectibility of the contract consideration is probable. The majority of our contracts have a single performance obligation to transfer products and are short term in nature, usually less than one year. Our revenue is measured based on the consideration specified in the contract with each customer in exchange for transferring products that is generally based upon a negotiated, formula, list or fixed price. Revenue is recognized when control of the promised goods is transferred to our customer, which is either upon shipment from our dock, receipt at the customer's dock, or removal from consignment inventory at the customer's location, in an amount that reflects the consideration we expect to be entitled to receive in exchange for those goods.

We have elected to account for shipping and handling as activities to fulfill the promise to transfer the goods. As such, shipping and handling fees billed to customers in a sales transaction are recorded in revenue and shipping and handling costs incurred are recorded in cost of revenue. Sales taxes and value added taxes in foreign jurisdictions that are collected from customers and remitted to governmental authorities are accounted for on a net basis and, therefore, are excluded from net sales.

We do not provide training, installation or commissioning services. We provide for future returns based on historical data, prior experience, current economic trends and changes in customer demand at the time revenue is recognized. We do not recognize any asset associated with the incremental cost of obtaining revenue generating customer contracts. As such, sales commissions are expensed as incurred, given that the expected period of benefit is less than one year.

On January 1, 2018, we adopted ASC Topic 606, Revenue from Contracts with Customers (“ASC 606”), and its related amendments, using the modified retrospective method applied to those contracts which were not completed as of January 1, 2018. The adoption of ASC 606, using the modified retrospective approach, had no significant impact to our accumulated deficit as of January 1, 2018 and no significant impact to the total net cash from or used in operating, investing, or financing activities within the consolidated statements of cash flows. In connection with this adoption on January 1, 2018, we reclassified our refund liabilities relating to sales with a right of return in the amount of \$169,000 to present it separately from “Accounts receivables” and included it in “Accrued liabilities” on the consolidated balance sheets.

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Contract Balances

We receive payments from customers based on a billing schedule as established in our contracts. Contract assets are recorded when we have a conditional right to consideration for our completed performance under the contracts. Accounts receivables are recorded when the right to this consideration becomes unconditional. We do not have any material contract assets as of December 31, 2018.

	December 31, 2018	December 31, 2017
Contract liabilities	\$ (476)	\$ (924)
Revenue recognized in the year ended		
Amounts included in contract liabilities at the beginning of the period	\$ 834	Not Applicable

Disaggregated Revenue

In general, revenue disaggregated by product types and geography (See Note 14) is aligned according to the nature and economic characteristics of our business and provides meaningful disaggregation of our results of operations. Since we operate in one segment, all financial segment and product line information can be found in the consolidated financial statements.

Practical Expedients and Exemptions

As part of our adoption of ASC 606, we elected to use the following practical expedients: (i) not to adjust the promised amount of consideration for the effects of a significant financing component when we expect, at contract inception, that the period between our transfer of a promised product or service to a customer and when the customer pays for that product or service will be one year or less; (ii) to expense costs as incurred for costs to obtain a contract when the amortization period would have been one year or less; (iii) not to assess whether promised goods or services are performance obligations if they are immaterial in the context of the contract with the customer.

In addition, we do not disclose the value of unsatisfied performance obligations for contracts with an original expected length of one year or less.

Accounting for Sales Taxes in Net Revenues

We record sales taxes collected on sales of our products and for amounts not yet remitted to tax authorities as accrued liabilities on our consolidated balance sheets.

Risks and Concentration of Credit Risk

Our business is very dependent on the semiconductor, lasers and optical industries which can be highly cyclical and experience downturns as a result of economic changes, overcapacity, and technological advancements. Significant technological changes in the industry or customer requirements, or the emergence of competitive products with new capabilities or technologies, could adversely affect our operating results. In addition, a significant portion of our revenues and net income is derived from international sales. Fluctuations of the United States dollar against foreign currencies and changes in local regulatory or economic conditions, particularly in an emerging market such as China, could adversely affect operating results.

We depend on a limited number of suppliers for certain raw materials, components and equipment used in manufacturing our products, including quartz tubing and polishing solutions. We generally purchase these materials through standard purchase orders and not pursuant to long-term supply contracts.

Financial instruments that potentially subject us to concentration of credit risk consist primarily of cash and cash equivalents, short-term investments, and trade accounts receivable. We invest primarily in money market accounts, certificates of deposit, corporate bonds and equity securities. The composition and maturities are regularly monitored by management. Such deposits are in excess of the amount of the insurance provided by the federal government on such

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deposits. We are exposed to credit risks in the event of default by the issuers to the extent of the amount recorded on the consolidated balance sheets.

We perform ongoing credit evaluations of our customers' financial condition, and limit the amount of credit extended when deemed necessary, but generally do not require collateral. The credit risk in our accounts receivable is mitigated by our credit evaluation process and the geographical dispersion of sales transactions. Three customers accounted for 17%, 12% and 10% of our trade accounts receivable as of December 31, 2018 and one customer accounted for 12% of our trade accounts receivable as of December 31, 2017.

One customer represented 13% of our revenue for the year ended December 31, 2018. Two customers represented 12% and 11%, respectively, of our revenue for the year ended December 31, 2017. No customer represented more than 10% of our revenue for the year ended December 31, 2016. Our top five customers, although not the same five customers for each period, represented 35% of our revenue for each of the years ended December 31, 2018, 2017 and 2016.

For the year ended December 31, 2018, each of three third-party customers for the raw materials products from our consolidated subsidiaries accounted for over 10% of the revenue from raw materials sales. For the year ended December 31, 2017, each of three third-party customers for the raw materials products from our consolidated subsidiaries accounted for over 10% of the revenue from raw materials sales while there were four third-party customers for the year ended December 31, 2016. Our subsidiaries and joint ventures are a key strategic benefit for us as they further diversify our sources of revenue.

Cash and Cash Equivalents

We consider investments in highly liquid instruments purchased with an original maturity of three months or less to be cash equivalents. Cash equivalents consist primarily of certificate of deposits. Cash and cash equivalents are stated at cost, which approximates fair value.

Short-Term and Long-Term Investments

We classify our investments in marketable debt and equity securities as available-for-sale securities. Short-term and long-term investments are comprised of available-for-sale marketable debt and equity securities, which consist primarily of certificates of deposit, corporate bonds and equity securities. These investments are reported at fair value as of the respective balance sheet dates with unrealized gains and losses included in accumulated other comprehensive income (loss) within stockholders' equity on the consolidated balance sheets. The amortized cost of securities is adjusted for amortization of premiums and accretion of discounts to maturity. Such amortization is included in "Other (expense) income, net" in the consolidated statements of operations. Realized gains and losses and declines in value judged to be other than temporary on available-for-sale securities are also included in "Other (expense) income, net" in the consolidated statements of operations. The cost of securities sold is based upon the specific identification method.

Accounts Receivable and Allowance for Doubtful Accounts and Sales Returns

Accounts receivable are recorded at the invoiced amount and are not interest bearing. We periodically review the likelihood of collection on our accounts receivable balances and provide an allowance for doubtful accounts receivable primarily based upon the age of these accounts. We evaluate receivables from U.S. customers with an emphasis on balances in excess of 90 days and for receivables from customers located outside the U.S. with an emphasis on balances in excess of 120 days and establish a reserve allowance on the receivable balances if needed.

The reason for the difference in the evaluation of receivables between foreign and U.S. customers is that U.S. customers have historically made payments in a shorter period of time than foreign customers. Foreign business practices generally require us to allow customer payment terms that are longer than those accepted in the United States. We assess the probability of collection based on a number of factors, including the length of time a receivable balance has been outstanding, our past history with the customer and their credit worthiness.

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We exercise judgment when determining the adequacy of these reserves as we evaluate historical bad debt trends, general economic conditions in the United States and internationally, and changes in customer financial conditions. Uncollectible receivables are recorded as bad debt expense when all efforts to collect have been exhausted and recoveries are recognized when they are received. As of December 31, 2018 and 2017, our accounts receivable, net balance was \$19.6 million and \$22.8 million, respectively, which was net of an allowance for doubtful accounts of \$358,000 in both December 31, 2018 and 2017. There were no changes in the allowance of doubtful accounts in 2018. During 2017, we decreased the allowance for doubtful accounts by \$295,000 due to \$138,000 from bad debt recovery and \$157,000 from bad debts written off in 2017. If actual uncollectible accounts differ substantially from our estimates, revisions to the estimated allowance for doubtful accounts would be required, which could have a material impact on our financial results for the future periods. If actual uncollectible accounts differ substantially from our estimates, revisions to the estimated allowance for doubtful accounts would be required, which could have a material impact on our financial results for future periods.

Historically, our allowance for sales returns reserve was deducted from gross accounts receivable. In connection with the adoption of ASC Topic 606, on January 1, 2018, we reclassified our refund liabilities relating to sales with a right of return in the amount of \$169,000 to present it separately from “Accounts receivables” and included it in “Accrued liabilities” on the consolidated balance sheets. As of December 31, 2018 and 2017, the balance was \$47,000 and \$169,000, respectively. During 2018, we utilized \$47,000 and reduced an additional \$75,000 and during 2017, we utilized \$119,000 and reduced an additional \$72,000.

Warranty Reserve

We maintain a warranty reserve based upon our claims experience during the prior twelve months and any pending claims and returns of which we are aware. Warranty costs are accrued at the time revenue is recognized. As of December 31, 2018 and 2017, accrued product warranties totaled \$236,000 and \$133,000, respectively. The increase in accrued product warranties is primarily attributable to increased claims for quality issues experienced by customers. If actual warranty costs or pending new claims differ substantially from our estimates, revisions to the estimated warranty liability would be required, which could have a material impact on our financial condition and results of operations for future periods.

Inventories

Inventories are stated at the lower of cost (approximated by standard cost) or net realizable value. Cost is determined using the weighted average cost method. Our inventory consists of raw materials as well as finished goods and work-in-process that include material, labor and manufacturing overhead costs. We routinely evaluate the levels of our inventory in light of current market conditions in order to identify excess and obsolete inventory, and we provide a valuation allowance for certain inventories to their estimated net realizable value based upon the age and quality of the product and the projections for sale of the completed products.

Property, Plant and Equipment

Property, plant and equipment are stated at cost less accumulated depreciation computed using the straight-line method over the estimated economic lives of the assets, which vary from 1 to 27.5 years. Leasehold improvements are amortized using the straight-line method over the shorter of the estimated useful life or the term of the lease. We generally depreciate computer, software, office equipment, furniture and fixtures 3 to 5 years, machinery and equipment 1 to 5 years, automobiles 5 to 10 years, leasehold and building improvements over 10 years, or lease term if shorter, and buildings over 27.5 years. Repairs and maintenance costs are expensed as incurred.

Impairment of Long-Lived Assets

We evaluate property, plant and equipment and intangible assets for impairment. When events and circumstances indicate that long-lived assets may be impaired, we compare the carrying value of the long-lived assets to the projection of future undiscounted cash flows attributable to these assets. In the event that the carrying value exceeds the future undiscounted cash flows, we record an impairment charge against income equal to the excess of the carrying

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value over the assets' fair value. Fair values are determined based on quoted market values, discounted cash flows or internal and external appraisals, as applicable. We did not recognize any impairment charges of long-lived assets in 2018, 2017 and 2016.

Impairment of Investments

All available-for-sale securities are periodically reviewed for impairment. An investment is considered to be impaired when its fair value is less than its amortized cost basis and it is more likely than not that we will be required to sell the impaired security before recovery of its amortized cost basis. Factors considered in determining whether a loss is temporary include the magnitude of the decline in market value, the length of time the market value has been below cost (or adjusted cost), credit quality, and our ability and intent to hold the securities for a period of time sufficient to allow for any anticipated recovery in market value.

We also invest in equity instruments of privately-held companies in China for business and strategic purposes. Investments in our unconsolidated joint venture companies are classified as other assets and accounted for under either the equity or cost method, depending on whether we have the ability to exercise significant influence over their operations or financial decisions. We monitor our investments for impairment and record reductions in carrying value when events or changes in circumstances indicate that the carrying value may not be recoverable. Determination of impairment is highly subjective and is based on a number of factors, including an assessment of the strength of each company's management, the length of time and extent to which the fair value has been less than our cost basis, the financial condition and near-term prospects of the subsidiary, fundamental changes to the business prospects of the company, share prices of subsequent offerings, and our intent and ability to hold the investment for a period of time sufficient to allow for any anticipated recovery in our carrying value. We estimate fair value of our cost method investments considering available information such as pricing in recent rounds of financing, current cash positions, earnings and cash flow forecasts, recent operational performance and any other readily available market data.

Segment Reporting

We operate in one segment for the design, development, manufacture and distribution of high-performance compound and single element semiconductor substrates and sale of raw materials integral to these substrates. Our chief operating decision-maker has been identified as our Chief Executive Officer, who reviews operating results to make decisions about allocating resources and assessing our performance for the Company. We discuss revenue and capacity for both AXT and our joint ventures collectively, when determining capacity constraints and need for raw materials in our business, and consider their capacity when determining our strategic and product marketing and advertising strategies. While we consolidate our majority-owned or significantly controlled joint ventures, we do not allocate any portion of overhead, interest and other income, interest expense or taxes to them. We therefore have determined that our joint venture operations do not constitute an operating segment. Since we operate in one segment, all financial segment and product line information can be found in the consolidated financial statements.

Stock Based Compensation

We have employee stock option plans, which are described more fully in Note 10—Employee Benefit Plans and Stock-based Compensation. We account for stock based compensation in accordance with the provisions of ASC Topic 718, Compensation-Stock Compensation (“ASC 718”). We utilize the Black Scholes option pricing model to estimate the grant date fair value of stock options, which requires the input of highly subjective assumptions, including estimating stock price volatility and expected term. Stock based compensation cost is measured at each grant date, based on the fair value of the award, and is recognized as expense and as an increase in additional paid-in capital over the requisite service period of the award.

Research and Development

Research and development costs consist primarily of salaries, including stock-based compensation expense and related personnel costs, depreciation, materials and product testing which are expensed as incurred. Tangible assets acquired for research and development purposes are capitalized if they have alternative future use.

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Advertising Costs

Advertising costs, included in selling, general and administrative expenses, are expensed as incurred. Advertising costs for the years ended December 31, 2018, 2017 and 2016 were less than \$10,000.

Income Taxes

We account for income taxes in accordance with ASC topic 740, Income Taxes (“ASC 740”), which requires that deferred tax assets and liabilities be recognized using enacted tax rates for the effect of temporary differences between the book and tax bases of recorded assets and liabilities. ASC 740 also requires that deferred tax assets be reduced by a valuation allowance if it is more likely than not that a portion of the deferred tax asset will not be realized. The impact of ASC 740 is more fully described in Note 12.

We have completed the accounting associated with the December 22, 2017 enactment of the U.S. Tax Cuts and Jobs Act (“Tax Reform”). The U.S. Securities and Exchange Commission (“SEC”) had provided accounting and reporting guidance that allowed us to report provisional amounts within a measurement period up to one year from the enactment date. Complexities inherent in adopting the changes included additional guidance, interpretations of the law, and further analysis of data and tax positions. As of December 2018, we do not expect there will be any significant adjustment to the impact of the Tax Reform.

Effective in 2018, the Tax Reform reduces the U.S. statutory tax rate from 35% to 21% and creates new taxes on certain foreign-sourced earnings and certain related-party payments, which are referred to as the global intangible low-taxed income tax and the base erosion tax, respectively. We have considered the impact of these new taxes in the current year’s provision calculation.

Comprehensive Income (Loss)

The components of other comprehensive income (loss) include unrealized gains and losses on marketable securities and foreign currency translation adjustments. Comprehensive income (loss) is presented in the consolidated statements of comprehensive income, net of tax. The balance of accumulated other comprehensive income (loss) is as follows (in thousands):

	As of December 31,	
	2018	2017
Accumulated other comprehensive income (loss):		
Unrealized loss on investments, net	\$ (84)	\$ (93)
Cumulative translation adjustment	(1,845)	3,904
	(1,929)	3,811
Less: Cumulative translation adjustment attributable to noncontrolling interests	43	404
Accumulated other comprehensive income (loss) attributable to AXT, Inc.	\$ (1,972)	\$ 3,407

Net Income (Loss) Per Share

Basic net income (loss) per share is computed using the weighted average number of common shares outstanding during the periods less shares of common stock subject to repurchase and non-vested stock awards. Diluted net

income (loss) per share is computed using the weighted average number of common shares outstanding and potentially dilutive common shares outstanding during the periods. The dilutive effect of outstanding stock options and restricted stock awards is reflected in diluted earnings per share by application of the treasury stock method. Potentially dilutive common shares consist of common shares issuable upon the exercise of stock options and vesting of restricted stock awards. Potentially dilutive common shares are excluded from the computation of weighted average number of common shares outstanding in net loss years, as their effect would be anti-dilutive to the computation.

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Recent Accounting Pronouncements

In January 2016, the FASB issued ASU 2016-01, which made changes to the accounting for financial instruments that primarily affect equity investments, financial liabilities under the fair value option, and the presentation and disclosure requirements for financial instruments. The amendments in this update supersede the guidance to classify equity securities with readily determinable fair values into different categories (that is, trading or available-for-sale) and require equity securities to be measured at fair value with changes in the fair value recognized through net income. The standard amends financial reporting by providing relevant information about an entity's equity investments and reducing the number of items that are recognized in other comprehensive income. This update became effective for annual periods beginning after December 15, 2017, and interim periods within those annual periods. We adopted this guidance effective January 1, 2018 and it did not have a significant impact on our consolidated financial statements.

In February 2016, the FASB issued ASU 2016-02, which replaces the existing guidance for leases. The new standard establishes a right-of-use ("ROU") model that requires a lessee to record a ROU asset and a lease liability on the balance sheet for all leases with terms longer than twelve months. Leases will be classified as either finance or operating, with classification affecting the pattern of expense recognition in the income statement. The guidance is effective for fiscal years beginning after December 15, 2018, including interim periods within those fiscal years and requires retrospective application.

The Company will adopt the new lease standard as of January 1, 2019 and plans to utilize the retrospective cumulative effect adjustment transition method with a cumulative effect adjustment being recorded as of the adoption date. The Company expects to elect certain available practical expedients including the package of practical expedients permitted under the transition guidance within the new standard, which among other things, will allow the Company to carry forward the historical lease classification. Additionally, the Company will make an accounting policy election to not record ROU assets and lease liabilities for leases with an initial term of twelve months or less on its consolidated balance sheet.

The Company has established a cross-functional implementation team and is in the process of finalizing the scope of arrangements that will be subject to this standard as well as assessing the impact to the Company's systems, processes, and internal controls over financial reporting. While the Company is still evaluating the impact of adopting ASU 2016-02, the Company anticipate this standard will have a material impact on the consolidated balance sheet. The primary impact will be to record ROU assets and lease liabilities for existing operating leases on the consolidated balance sheets.

The Company does not expect the adoption to have a material impact on its consolidated statements of operations or its consolidated statements of cash flows. The Company does not believe the standard will have a notable impact on its liquidity. The Company's analysis and evaluation of the new standard will continue through its effective date in the first quarter of 2019, including continuing to monitor any potential changes in the standard proposed by the FASB.

In August 2016, the FASB issued ASU No. 2016-15, which reduces diversity in practice where the FASB was either unclear or did not provide specific guidance for classifying cash payments and receipts in the statement of cash flows for eight specific transactions. The guidance is effective for fiscal years beginning after December 15, 2017, including interim periods within those fiscal years and requires retrospective application with early application permitted. We adopted this guidance effective January 1, 2018 and it did not have a significant impact on our consolidated financial statements.

In October 2016, the FASB issued ASU No. 2016-16, which clarifies the accounting for the current and deferred income taxes for an intra-entity transfer of an asset other than inventory. The guidance is effective for fiscal years beginning after December 15, 2017, including periods within those fiscal years and requires retrospective application with early application permitted. We adopted this guidance effective January 1, 2018 and it did not have a significant impact on our consolidated financial statements.

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In January 2017, the FASB issued ASU No. 2017-01, which clarifies the definition of a business with the objective of adding guidance to assist entities with evaluating whether transactions should be accounted for as acquisitions (or disposals) of assets or businesses. The definition of a business affects many areas of accounting including acquisitions, disposals, goodwill, and consolidation. The guidance is effective for fiscal years beginning after December 15, 2017, including periods within those fiscal years and requires retrospective application with early application permitted. We adopted this guidance effective January 1, 2018 and it did not have a significant impact on our consolidated financial statements.

In May 2017, the FASB issued ASU No. 2017-09, Compensation - Stock Compensation (Topic 718): Scope of Modification Accounting. The guidance provides clarity and reduces diversity in practice and cost and complexity when accounting for a change to the terms or conditions of a share-based payment award. The guidance is effective for fiscal years beginning after December 15, 2017. We adopted this guidance effective January 1, 2018 and it did not have a significant impact on our consolidated financial statements.

Note 2. Cash, Cash Equivalents and Investments

Our cash and cash equivalents consist of cash and instruments with original maturities of less than three months. Our investments consist of instruments with original maturities of more than three months. As of December 31, 2018 and 2017, our cash, cash equivalents and investments are classified as follows (in thousands):

	December 31, 2018				December 31, 2017			
	Amortized Cost	Gross Unrealized Gain	Gross Unrealized (Loss)	Fair Value	Amortized Cost	Gross Unrealized Gain	Gross Unrealized (Loss)	Fair Value
Classified as:								
Cash	\$ 16,526	\$ —	\$ —	\$ 16,526	\$ 43,610	\$ —	\$ —	\$ 43,610
Cash equivalents:								
Certificates of deposit 1	—	—	—	—	742	—	—	742
Total cash and cash equivalents	16,526	—	—	16,526	44,352	—	—	44,352
Investments (available-for-sale):								
Certificates of deposit 2	4,508	—	(27)	4,481	7,099	—	(24)	7,075
Corporate bonds	18,422	—	(57)	18,365	25,602	—	(69)	25,533
Total investments	22,930	—	(84)	22,846	32,701	—	(93)	32,608
Total cash, cash equivalents and investments	\$ 39,456	\$ —	\$ (84)	\$ 39,372	\$ 77,053	\$ —	\$ (93)	\$ 76,960
Contractual maturities on investments:								
Due within 1 year 3	\$ 22,210			\$ 22,129	\$ 20,056			\$ 20,032
Due after 1 through 5 years 4	720			717	12,645			12,576

\$ 22,930

\$ 22,846 \$ 32,701

\$ 32,608

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1. Certificate of deposit with original maturities of less than three months.
 2. Certificate of deposit with original maturities of more than three months.
 3. Classified as "Short-term investments" in our consolidated balance sheets.
 4. Classified as "Long-term investments" in our consolidated balance sheets.

We manage our investments as a single portfolio of highly marketable securities that is intended to be available to meet our current cash requirements. Certificates of deposit and corporate bonds are typically held until maturity. Corporate equity securities have no maturity and may be sold at any time. Our holding of corporate equity securities consisted of common stock of GCS Holdings, Inc. ("GHI") (previously Global Communication Semiconductors, Inc), a Taiwan publicly-traded company. Previously, we also owned the common stock of Intelligent Epitaxy Technology, Inc.

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(“IntelliEpi”). We began classifying IntelliEpi stock as an available-for-sale security upon its initial public offering in 2013 and sold our remaining IntelliEpi stock in the second quarter of 2015 and we no longer hold any IntelliEpi stock as of December 31, 2018.

We began classifying GHI as an available-for-sale security in the second quarter of 2015 when we determined that there was sufficient trading volume in the exchange for the stock to be deemed readily marketable. As of December 31, 2018 and 2017, we no longer hold any GHI stock. During 2017, our cash proceeds from sales of GHI stock were \$125,000. Our cost was \$48,000 and our gross realized gain from sales of GHI stock was \$77,000. During the three months ended March 31, 2017, we sold the remainder of our GHI stock. An unrealized gain of \$111,000, net of tax, was recorded as of December 31, 2016. In 2016, we sold some of our GHI stock and our cash proceeds from sales of this available-for-sale investment was \$581,000. Our cost was \$152,000 and our gross realized gain from sales of this available-for-sale investment was \$429,000.

The gross unrealized losses related to our portfolio of available-for-sale securities were primarily due to changes in interest rates and market and credit conditions of the underlying securities. We have determined that the gross unrealized losses on some of our available-for-sale securities as of December 31, 2018 are temporary in nature. We periodically review our investment portfolio to identify and evaluate investments that have indications of possible impairment. Factors considered in determining whether a loss is temporary include the magnitude of the decline in market value, the length of time the market value has been below cost (or adjusted cost), credit quality, and our ability and intent to hold the securities for a period of time sufficient to allow for any anticipated recovery in market value.

A portion of our investments would generate a loss if we sold them on December 31, 2018. The following table summarizes the fair value and gross unrealized losses related to available-for-sale securities, aggregated by investment category and length of time that individual securities have been in a continuous unrealized loss position as of December 31, 2018 (in thousands):

	In Loss Position < 12 months		In Loss Position > 12 months		Total In Loss Position	
	Fair Value	Gross Unrealized (Losses)	Fair Value	Gross Unrealized (Losses)	Fair Value	Gross Unrealized (Losses)
As of December 31, 2018						
Investments:						
Certificates of deposit	\$ 717	\$ (3)	\$ 3,746	\$ (24)	\$ 4,463	\$ (27)
Corporate bonds	9,175	(29)	9,189	(28)	18,364	(57)
Total in loss position	\$ 9,892	\$ (32)	\$ 12,935	\$ (52)	\$ 22,827	\$ (84)

The following table summarizes the fair value and gross unrealized losses related to available-for-sale securities, aggregated by investment category and length of time that individual securities have been in a continuous unrealized loss position as of December 31, 2017 (in thousands):

	In Loss Position < 12 months		In Loss Position > 12 months		Total In Loss Position	
	Fair Value	Gross Unrealized (Loss)	Fair Value	Gross Unrealized (Loss)	Fair Value	Gross Unrealized (Loss)
As of December 31, 2017						
Investments:						

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Certificates of deposit	\$ 3,994	\$ (16)	\$ 2,342	\$ (8)	\$ 6,336	\$ (24)
Corporate bonds	25,533	(69)	—	—	25,533	(69)
Total in loss position	\$ 29,527	\$ (85)	\$ 2,342	\$ (8)	\$ 31,869	\$ (93)

Investments in Privately-held Companies

We have made strategic investments in private companies located in China in order to gain access at a competitive cost to raw materials that are critical to our substrate business (see Note 6). The investment balances for all of these companies, including minority investments indirectly in privately-held companies made by our consolidated

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subsidiaries, are accounted for under the equity method and included in “Other assets” in the consolidated balance sheets and totaled \$8.4 million and \$9.8 million as of December 31, 2018 and 2017, respectively. As of December 31, 2018 there were seven companies accounted for under the equity method. We had no impairment charges during 2018. For the year ended December 31, 2017, we recognized an impairment charge of \$313,000 for one of the gallium companies. During the first quarter of 2017, management determined it unlikely that this company will recover from the difficult pricing environment and we wrote the investment down to zero. We had no impairment charges during 2016.

As noted above, in the second quarter of 2015, we re-classified our minority investment in GHI, which was accounted for under the cost method, as an available-for-sale security and valued the security at fair market value. As of December 31, 2018 and 2017, we no longer maintain any investments under the cost method.

Fair Value Measurements

We invest primarily in money market accounts, certificates of deposit, corporate bonds and notes, and government securities. ASC Topic 820, Fair Value Measurements and Disclosures (“ASC 820”), establishes three levels of inputs that may be used to measure fair value. Level 1 instrument valuations are obtained from real-time quotes for transactions in active exchange markets of the asset or identical assets. Level 2 instrument valuations are obtained from readily-available, observable pricing sources for comparable instruments. Level 3 instrument valuations are obtained from unobservable inputs in which there is little or no market data, which require us to develop our own assumptions. On a recurring basis, we measure certain financial assets and liabilities at fair value, primarily consisting of our short-term and long-term investments.

The type of instrument valued based on quoted market prices in active markets include our money market funds, which are generally classified within Level 1 of the fair value hierarchy. Other than corporate equity securities which are based on quoted market prices and classified as Level 1, we classify our available-for-sale securities including certificates of deposit and corporate bonds as having Level 2 inputs. The valuation techniques used to measure the fair value of these financial instruments having Level 2 inputs were derived from bank statements, quoted market prices, broker or dealer statements or quotations, or alternative pricing sources with reasonable levels of price transparency. There were no changes in valuation techniques or related inputs in the year ended December 31, 2018. There have been no transfers between fair value measurement levels during the year ended December 31, 2018.

We place short-term foreign currency hedges that are intended to offset the potential cash exposure related to fluctuations in the exchange rate between the United States dollar and Japanese yen. We measure the fair value of these foreign currency hedges at each month end and quarter end using current exchange rates and in accordance with generally accepted accounting principles. At quarter end any foreign currency hedges not settled are netted in “Accrued liabilities” on the consolidated balance sheets and classified as Level 3 assets and liabilities. As of December 31, 2018, the net change in fair value from the placement of the hedge to settlement at each month end during the quarter had a de minimis impact to the consolidated results.

The following table summarizes our financial assets and liabilities measured at fair value on a recurring basis in accordance with ASC 820 as of December 31, 2018 (in thousands):

	Balance as of December 31, 2018	Quoted Prices in Active Markets of Identical Assets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
Assets:				

Cash equivalents and
investments:

Certificates of deposit	\$ 4,481	\$ —	\$ 4,481	\$ —
Corporate bonds	18,365	—	18,365	—
Total	\$ 22,846	\$ —	\$ 22,846	\$ —

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The following table summarizes our financial assets and liabilities measured at fair value on a recurring basis in accordance with ASC 820 as of December 31, 2017 (in thousands):

	Balance as of December 31, 2017	Quoted Prices in Active Markets of Identical Assets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
Assets:				
Cash equivalents and investments:				
Certificates of deposit	\$ 7,817	\$ —	\$ 7,817	\$ —
Corporate bonds	25,533	—	25,533	—
Total	\$ 33,350	\$ —	\$ 33,350	\$ —

Items Measured at Fair Value on a Nonrecurring Basis

Certain assets that are subject to nonrecurring fair value measurements are not included in the table above. These assets include investments in privately-held companies accounted for by equity and cost method (See Note 6). We had no impairment charges 2018. For the year ended in December 31, 2017, we recognized an impairment charge of \$313,000 for one of the gallium companies. During the first quarter of 2017, management determined it was unlikely that this company would recover from the difficult pricing environment and we wrote the investment down to zero. We had no impairment charges 2016.

Note 3. Inventories

The components of inventory are summarized below (in thousands):

	December 31, 2018	December 31, 2017
Inventories:		
Raw materials	\$ 26,966	\$ 23,554
Work in process	28,217	20,135
Finished goods	3,388	2,151
	\$ 58,571	\$ 45,840

As of December 31, 2018 and 2017, carrying values of inventories were net of inventory reserves of \$14.8 million and \$13.3 million, respectively, for excess and obsolete inventory and \$18,000 and \$291,000, respectively, for lower of cost or net realizable value reserves.

Note 4. Related Party Transactions

In August 2011, our consolidated joint venture, Beijing JiYa Semiconductor Material Co., Ltd. (“JiYa”), entered into a non-interest bearing note agreement in the amount of \$1.6 million for a loan to one of its equity investment entities. The original term of the loan was for two years and ten months with three periodic principal payments required. After various amendments to the terms of the note, in December 2013 the parties agreed to delay all principal repayment

until December 2017. In December 2016, we determined that this receivable was in substance an investment and began re-classifying this long-term loan from “Related party notes receivable – long-term” to “Other assets” in our consolidated balance sheets. As of December 31, 2018 and 2017, we included \$1.0 million and \$1.2 million, respectively, in “Other assets” in our consolidated balance sheets.

JiYa also purchases raw materials from one of its equity investment entities for production in the ordinary course of business. The general manager of JiYa has a family member who has a 10% ownership position in this equity investment entity. As of December 31, 2018 and 2017, amounts payable of \$1.9 million and \$2.1 million, respectively, were included in “Accounts payable” in our consolidated balance sheets.

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JiYa also sells raw materials to one of its equity investment entities for production in the ordinary course of business. As of December 31, 2018 and 2017, amounts receivable of \$316,000 and \$334,000, respectively, were included in “Accounts receivable” in our consolidated balance sheets. During the three months ended December 31, 2016, we deemed the collection of the outstanding amount to be improbable and established an allowance in full. There have since been no additional sales made on credit to the customer and as of December 31, 2018 the existing outstanding amount continues to be fully reserved.

Beginning in 2012, our consolidated joint venture, Nanjing JinMei Gallium Co., Ltd. (“JinMei”), is contractually obligated under an agency sales agreement to sell raw material on behalf of its equity investment entity. JinMei bills the customers and remits the receipts, net of its portions of sales commission, to this equity investment entity. For the years ended December 31, 2018 and 2017, JinMei recorded \$24,000 and \$3,000 of income from agency sales, respectively, which were included in “Other (expense) income, net” in the consolidated statements of operations.

In March 2012, our wholly-owned subsidiary, Beijing Tongmei Xtal Technology Co., Ltd. (“Tongmei”), entered into an operating lease for the land it owns with our consolidated joint venture, Beijing BoYu Semiconductor Vessel Craftwork Technology Co., Ltd. (“BoYu”). The lease agreement for the land of approximately 22,081 square feet commenced on January 1, 2012 for a term of 10 years with annual lease payments of \$24,000 subject to a 5% increase at each third year anniversary. The annual lease payment is due by January 31st of each year.

Tongmei has paid certain amounts on behalf of Donghai County Dongfang High Purity Electronic Materials Co., Ltd. (“Dongfang”), its equity investment entity, to purchase materials. The original agreement was signed between Tongmei and Dongfang in 2014 and the date of repayment was set as December 31, 2015. In 2015, both parties agreed to delay the date of repayment to December 31, 2017. During 2017, the repayment of the full amount of principal and interest totaling \$114,000 was received by our wholly owned subsidiary.

In April 2014, Tongmei loaned an additional of \$46,000 to Dongfang. The loan bears interest at 6.15% per annum and comes due on December 31, 2017. During 2017, the repayment of the full amount of principal and interest totaling \$55,000 was received by our wholly owned subsidiary.

Tongmei also purchases raw materials from Dongfang for production in the ordinary course of business. As of December 31, 2018 and 2017, amount payable of \$59,000 and \$0, respectively, were included in “Accounts payable” in our consolidated balance sheets.

Tongmei also purchases raw materials from one of our equity investment entities, Emei Shan Jiamei Materials Co. Ltd. (“Jiamei”), for production in the ordinary course of business. As of December 31, 2018 and 2017, amount payable of \$0 and \$370,000, respectively, were included in “Accounts payable” in our consolidated balance sheets.

Tongmei also purchases raw materials from one of our equity investment entities, Xilingol Tongli Germanium Refine Co. Ltd. (“Tongli”), for production in the ordinary course of business. As of December 31, 2018 and 2017, amount payable of \$0 and \$219,000, respectively, were included in “Accounts payable” in our consolidated balance sheets.

In July 2017, Tongmei, provided an inter-company loan to JinMei in the amount of \$768,000 in preparation for the acquisition of the land use rights and the construction of a new building. The inter-company loan carries an interest rate of 4.9% per annum. The principle is due in three installments between December 2021 and December 2023 while the interest is due in December of each year. During 2018, JinMei repaid principal and interest totaling \$453,000 to Tongmei. As of December 31, 2018, the remaining balance of principal and interest totaled \$316,000. JinMei, is in the process of relocating its headquarters and manufacturing operations to the city of Kazuo, located in the province of

Liaoning near the Inner Mongolia Autonomous Region, very near our own location. Currently, JinMei expects to invest approximately \$2.5 to \$3.5 million related to the new facilities in 2019.

In April 2016, our consolidated joint venture, BoYu, provided a personal loan of \$177,000 to one of its executive employees. This loan is secured by the officer's shares in BoYu. The loan bears interest at 2.75% per annum. Principal and accrued interest are due on March 31, 2019. During the three months ended June 30, 2017, the repayment

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of the principal and interest totaling \$180,000 was received by our consolidated joint venture. In November 2017, BoYu provided another personal loan of \$291,000 to the same executive employee. The loan bears interest at 2.75% per annum. Principal and accrued interest are due on November 30, 2020. As of December, 2018 and 2017, the balances, including both principal and accrued interest, were \$299,000 and \$291,000, respectively, and included in “Other assets” and “Prepaid expenses and other current assets”, respectively, in our consolidated balance sheets.

On November 2, 2017, our consolidated joint venture, BoYu, raised additional capital in the amount of \$2 million in cash from a third-party investor through the issuance of shares equivalent to 10% ownership of BoYu. This third-party investor is an immediate family member to the owner of one of BoYu's customers. For the years ended December 31, 2018 and 2017, BoYu has recorded \$1.5 million and \$1.2 million in revenue from this customer, respectively. As of December 31, 2018 and 2017, amounts receivable of \$0 and \$635,000, respectively, were included in “Accounts receivable” in our consolidated balance sheets.

Our Related Party Transactions Policy seeks to prohibit all conflicts of interest in transactions between related parties and us, unless they have been approved by our Board of Directors. This policy applies to all of our employees, directors, and our consolidated subsidiaries. Our executive officers retain board seats on the Board of Directors of the companies in which we have invested in our China joint ventures. See Note 6 for further details.

Note 5. Property, Plant and Equipment, Net

The components of our property, plant and equipment are summarized below (in thousands):

	December 31, 2018	December 31, 2017
Property, plant and equipment:		
Machinery and equipment, at cost	\$ 51,496	\$ 44,549
Less: accumulated depreciation and amortization	(41,431)	(40,845)
Building, at cost	39,775	32,461
Less: accumulated depreciation and amortization	(12,147)	(11,501)
Leasehold improvements, at cost	5,464	5,539
Less: accumulated depreciation and amortization	(4,497)	(4,288)
Construction in progress	43,620	20,615
	\$ 82,280	\$ 46,530

As of December 31, 2018, the balance of construction in progress was \$43.6 million, of which \$31.7 million was related to our buildings in our new Dingxing and Chaoyang locations, \$2.2 million was for manufacturing equipment purchases not yet placed in service and \$9.7 million was from our construction in progress for our other consolidated subsidiaries. As of December 31, 2017, the balance of construction in progress was \$20.6 million, of which, \$14.8 million was for our buildings in our new Dingxing location, \$3.6 million was for manufacturing equipment purchases not yet placed in service, and \$2.2 million was for our construction in progress at our other consolidated subsidiaries.

Depreciation and amortization expense was \$4.9 million, \$4.4 million and \$4.9 million for the years ended 2018, 2017 and 2016, respectively.

Note 6. Investments in Privately-held Companies

We have made strategic investments in private companies located in China in order to gain access at a competitive cost to raw materials that are critical to our substrate business. We have six direct investments. Our consolidated subsidiaries have also made investments in private companies. We have four indirect investments. These companies form part of our overall supply chain.

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Our direct investments are summarized below (in thousands):

Company	Investment Balance as of		Accounting Method	Ownership Percentage	
	December 31, 2018	December 31, 2017			
Beijing JiYa Semiconductor Material Co., Ltd.	\$ 3,331	\$ 3,331	Consolidated	46	%
Nanjing JinMei Gallium Co., Ltd.	592	592	Consolidated	97	%
Beijing BoYu Semiconductor Vessel Craftwork Technology Co., Ltd.	1,346	1,346	Consolidated	63	%
	\$ 5,269	\$ 5,269			
Donghai County Dongfang High Purity Electronic Materials Co., Ltd.	\$ 1,416	\$ 1,473	Equity	46	%
Xilingol Tongli Germanium Co. Ltd.	1,700	3,190	Equity	25	%
Emeishan Jia Mei High Purity Metals Co., Ltd.	842	915	Equity	25	%
	\$ 3,958	\$ 5,578			

Our ownership of JiYa is 46%. We continue to consolidate JiYa as we are the founding and largest shareholder, we appoint the general manager and controller and have the ability to exercise control in substance over the long-term strategic decisions made. Our Chief Executive Officer is chairman of the JiYa board and we have appointed one other representative, Davis Zhang, to serve on the board. Mr. Zhang was an executive officer of AXT for 27 years. Further, our Chief Financial Officer, Gary Fischer, is on the board of supervisors of JiYa.

Our ownership of JinMei is 97%. Before June 15, 2018, our ownership of JinMei was 83%. On June 15, 2018, we purchased a 12% ownership interest from one of the minority owners for \$1.4 million. The \$1.4 million is scheduled to be paid in two installments. On June 15, 2018, we paid the first installment of \$163,000. The second installment of \$1.2 million is scheduled to be paid after the completion of the relocation of JinMei's headquarters and manufacturing operations and was included in "Accrued liabilities" in our consolidated balance sheets. As a result, our ownership of JinMei increased from 83% to 95%. In September 2018, we purchased a 2% ownership interest from one of the three remaining minority owners for \$252,000. As a result, our ownership of JinMei increased from 95% to 97%. We continue to consolidate JinMei as we have a controlling financial interest and have majority control of the board. Our Chief Executive Officer is chairman of the JinMei board and we have appointed two other representatives to serve on the board.

Our ownership of BoYu is 63%. On November 2, 2017, BoYu raised additional capital in the amount of \$2 million in cash from a third-party investor through the issuance of shares equivalent to 10% ownership of BoYu. As a result, our ownership of BoYu was diluted from 70% to 63%. We continue to consolidate BoYu as we have a controlling financial interest and have majority control of the board and accordingly no gain was recognized as a result of this equity transaction. Our Chief Executive Officer is chairman of the BoYu board and we have appointed two other representatives to serve on the board.

Although we have representation on the boards of directors of each of these companies, the daily operations of each of these companies are managed by local management and not by us. Decisions concerning their respective short-term strategy and operations, ordinary course of business capital expenditures, and decisions concerning sales of finished product, are made by local management with regular guidance and input from us.

During 2018, 2017 and 2016, the three consolidated joint ventures generated \$5.5 million, \$2.1 million and \$0.1 million of income, respectively, of which an income of \$1.4 million, a loss of \$0.1 million and a loss of \$0.7 million, respectively were allocated to noncontrolling interests, resulting in \$4.1 million, \$2.2 million and \$0.8 million of income, respectively, to our net income.

For AXT's three direct minority investment entities that are not consolidated, the investment balances are included in "Other assets" in our consolidated balance sheets and totaled \$4.0 million and \$5.6 million as of December

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31, 2018 and 2017, respectively. We own 46% of the ownership interests in one of these companies and 25% in each of the other two companies. These three companies are not considered variable interest entities because:

- all three companies have sustainable businesses of their own;
- our voting power is proportionate to our ownership interests;
- we only recognize our respective share of the losses and/or residual returns generated by the companies if they occur; and
- we do not have controlling financial interest in, do not maintain operational or management control of, do not control the board of directors of, and are not required to provide additional investment or financial support to any of these companies.

These three equity investment entities generated for AXT an equity loss of \$1.6 million, \$0.9 million and \$1.2 million for the year ended December 31, 2018, 2017 and 2016, respectively, which was recorded as “Equity in (loss) earnings of unconsolidated joint ventures” in the consolidated statements of operations.

Net income recorded from all of the consolidated joint ventures and these three equity investment entities was \$2.6 million for the year ended December 31, 2018. Net income recorded from all of the consolidated joint ventures and these three equity investment entities was \$1.3 million for the year ended December 31, 2017. Net loss recorded from all of the consolidated joint ventures and these three equity investment entities was \$0.4 million for the year ended December 31, 2016.

We also maintain four minority investments indirectly in privately-held companies through our consolidated joint ventures. JiYa holds three investments and JinMei holds one investment. These minority investments are accounted for under the equity method in the books of our consolidated joint ventures. As of December 31, 2018 and 2017, our consolidated joint ventures included these minority investments in “Other assets” in the consolidated balance sheets with a carrying value of \$4.5 million and \$4.3 million, respectively.

AXT’s three direct minority investment entities and the three minority investments of JiYa and the one minority investment of JinMei are not consolidated and are accounted for under the equity method. Excluding one fully impaired entity, the equity entities had the following summarized income information (in thousands) for the years ended December 31, 2018, 2017 and 2016, respectively:

	Year Ended December 31,			Our share for the Year Ended December 31,		
	2018	2017	2016	2018	2017	2016
Net revenue	\$ 33,212	\$ 24,053	\$ 23,266	\$ 8,549	\$ 6,152	\$ 6,124
Gross profit (loss)	6,457	1,739	(2,191)	1,675	482	(511)
Operating (loss)	(3,152)	(3,676)	(6,869)	(778)	(938)	(1,724)
Net (loss)	(4,750)	(4,798)	(7,428)	(1,080)	(1,381)	(1,891)

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Excluding one fully impaired entity, these minority investment entities that are not consolidated, but rather are accounted for under the equity method, had the following summarized balance sheet information (in thousands) as of December 31, 2018 and 2017, respectively:

	As of December 31,	
	2018	2017
Current assets	\$ 31,525	\$ 33,415
Noncurrent assets	26,889	28,964
Current liabilities	24,670	27,274
Noncurrent liabilities	112	180

Our portion of the entity loss, excluding impairment charges, from all seven minority investment entities that are not consolidated and are accounted for under the equity method were a loss of \$1.1 million, \$1.4 million, and \$2.0 million for the years ended December 31, 2018, 2017 and 2016, respectively. Dividends received from these minority investment entities were \$0 for each of the years ended December 31, 2018, 2017 and 2016. Excluding one fully impaired entity, undistributed retained earnings relating to our investments in these minority investment entities amounted to \$2.5 million and \$3.6 million as of December 31, 2018 and 2017, respectively.

Note 7. Balance Sheets Details

Other Assets

The components of other assets are summarized below (in thousands):

	As of December 31,	
	2018	2017
Equity method investments	8,422	9,849
Value added tax receivable, long term	1,845	—
Other intangible assets	1,048	1,148
Other assets	672	576
	\$ 11,987	\$ 11,573

Accrued Liabilities

The components of accrued liabilities are summarized below (in thousands):

	As of December 31,	
	2018	2017
Accrued compensation and related charges	3,440	3,205
Preferred stock dividends payable	2,901	2,901
Payable in connection with constructions	2,912	—
Payable in connection with repurchase of subsidiaries shares	1,147	—
Deferred government grant income in connection with purchase of land	1,000	—
Accrued professional services	706	583
Dividends payable by consolidated joint ventures	504	533
Advance from customers	476	924

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Other tax payable	261	395
Accrued product warranty	236	133
Other personnel related costs	202	230
Accrued income taxes	99	270
Accrual for sales refund liabilities	47	—
Current portion of royalty payments	—	575
Other accrued liabilities	1,440	1,400
	\$ 15,371	\$ 11,149

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Note 8. Bank Loans and Line of Credit

In September 2018, Tongmei entered into a credit facility with Industrial and Commercial Bank of China (“ICBC”) in China with a \$2.9 million line of credit at an annual interest rate of approximately 0.04% over the current Loan Prime Rate published by ICBC. Accrued interest is calculated and paid monthly. The annual interest rate was approximately 4.4%. This credit line is secured by Tongmei’s land-use right and all of its buildings located at its facility in Beijing. The primary intended use of the credit facility is for general purposes, which may include working capital, capital expenditures and other corporate expenses. In September 2018, we borrowed \$291,000 against this credit line. The repayment of the full amount is due in September 2019. On December 26, 2018, we repaid the principal of \$291,000 and interest of \$3,000 of this loan to the bank. This credit line was terminated in December 2018, after we repaid both principal and interest to ICBC. We have decided to terminate this loan because we were able to secure a larger bank loan in the U.S. and our management believed that to secure bank loans from the two new manufacturing sites have more strategic advantages as compared to have one single loan from Beijing.

On November 6, 2018, the Company entered into the Credit Agreement, which established a \$10 million secured revolving line of credit with a \$1.0 million letter of credit sublimit facility. The revolving credit facility is collateralized by substantially all of the assets of the Company located within the United States, subject to certain exceptions. The commitments under the Credit Agreement expire on November 30, 2020 and any loans thereunder will bear interest at a rate based on the daily one-month LIBOR for the applicable interest period plus a margin of 2%. As of December 31, 2018, no loans or letters of credit were outstanding under the Credit Agreement.

Note 9. Stockholders’ Equity and Stock Repurchase Program

Stockholders’ Equity

The 883,000 shares of \$0.001 par value Series A preferred stock issued and outstanding as of December 31, 2018 and 2017, valued at \$3,532,000 are non-voting and non-convertible preferred stock with a 5.0% cumulative annual dividend rate payable when declared by the Board of Directors and \$4 per share liquidation preference over common stock, and must be paid before any distribution is made to common stockholders. These preferred shares were issued to Lyte Optronics, Inc. stockholders in connection with the completion of our acquisition of Lyte Optronics, Inc. on May 28, 1999.

Changes in AXT, Inc.’s ownership interest in consolidated subsidiaries.

The effects of changes in the Company’s ownership interests in its less than 100% owned subsidiaries on the Company’s equity are as follows:

	As of December 31,	
	2018	2017
Net income attributable to AXT, Inc.	\$ 9,654	\$ 10,148
Changes in paid-in capital for:		
Sales of subsidiary shares to noncontrolling interest	—	1,765
Purchase of subsidiary shares from noncontrolling interest	187	—
Net transfers to noncontrolling interests	187	1,765

Net income attributable to AXT, Inc., net of transfers to noncontrolling interests	\$ 9,841	\$ 11,913
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Stock Repurchase Program

On February 21, 2013, our Board of Directors approved a stock repurchase program pursuant to which we may repurchase up to \$6.0 million of our outstanding common stock through February 27, 2014. These purchases were to be made from time to time in the open market and were funded from our existing cash balances and cash generated from operations. During 2013, we repurchased approximately 285,000 shares at an average price of \$2.51 per share for a total

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purchase price of \$716,000 under the stock repurchase program. As of December 31, 2013, approximately \$5.3 million remained available for future repurchases under this program. No shares were repurchased in 2014 under this program and the plan expired on February 27, 2014.

On October 27, 2014, our Board of Directors approved a stock repurchase program pursuant to which we may repurchase up to \$5.0 million of our outstanding common stock. These repurchases can be made from time to time in the open market and are funded from our existing cash balances and cash generated from operations. During 2015, we repurchased approximately 908,000 shares at an average price of \$2.52 per share for a total purchase price of approximately \$2.3 million under the stock repurchase program. No shares were repurchased during 2018, 2017 and 2016 under this program. As of December 31, 2018, approximately \$2.7 million remained available for future repurchases under this program.

By the terms of the Series A preferred stock, so long as any shares of Series A preferred stock are outstanding, neither the Company nor any subsidiary of the Company shall redeem, repurchase or otherwise acquire any shares of common stock, unless all accrued dividends on the Series A preferred stock have been paid. During 2013 and 2015, we repurchased shares of our outstanding common stock. As of December 31, 2015, the Series A preferred stock had cumulative dividends of \$2.9 million and we included this amount in “Accrued liabilities” in our consolidated balance sheets. In 2016, 2017 and 2018, we did not repurchase any of our outstanding common stock. If we are required to pay the cumulative dividends on the Series A preferred stock, our cash and cash equivalents would be reduced. We account for the cumulative year to date dividends on the Series A preferred stock when calculating our earnings per share.

Note 10. Employee Benefit Plans and Stock-based Compensation

Stock Option Plans and Equity Incentive Plans

In May 2007, our stockholders approved our 2007 Equity Incentive Plan (the “2007 Plan”), which provides for the grant of incentive and non-qualified stock options to our employees, consultants and directors. The 2007 Plan is a restatement of the 1997 Stock Option Plan which expired in 2007. The 1,928,994 share reserve of the 1997 Stock Option Plan became the reserve of the 2007 Plan, together with 1,300,000 additional shares approved for issuance under the 2007 Plan. In May 2013, the stockholders approved an additional 2,000,000 shares to be issued under the 2007 plan. Awards may be made under the 2007 Plan are stock options, stock appreciation rights, restricted stock, restricted stock units, performance shares, performance units, deferred compensation awards and other stock based awards. Stock options and stock appreciation rights awarded under the 2007 Plan may not be repriced without stockholder approval. Stock options and stock appreciation rights may not be granted below fair market value. Stock options or stock appreciation rights generally shall not be fully vested over a period of less than three years from the date of grant and cannot be exercised more than 10 years from the date of grant. Restricted stock, restricted stock units, and performance awards generally shall not vest faster than over a three-year period (or a twelve month period if vesting is based on a performance measure). In December 2008, the 2007 Plan was amended to comply with the applicable requirements under Section 409A of the Internal Revenue Code.

In May 2015, our stockholders approved our 2015 Equity Incentive Plan (the “2015 Plan”). The 2015 Plan is a replacement of the 2007 Plan. The 399,562 share reserve of the 2007 Plan became the reserve of the 2015 Plan, together with 3,000,000 additional shares approved for issuance under the 2015 Plan. Awards that may be made under the 2015 Plan are stock options, stock appreciation rights, restricted stock, restricted stock units, performance shares, performance units, deferred compensation awards and other stock based awards. Stock options and stock appreciation rights awarded under the 2015 Plan may not be repriced without stockholder approval. Stock options and stock appreciation rights may not be granted below fair market value. Stock options or stock appreciation rights generally shall not be fully vested over a period of less than four years from the date of grant and cannot be exercised more than

10 years from the date of grant. Restricted stock, restricted stock units, and performance awards generally shall not vest faster than over a three-year period (or a twelve month period if vesting is based on a performance measure). However, options granted to consultants and restricted stock awards granted to independent board members typically vest in one year and the 2015 Plan does allow for similar vesting to employees. As of December 31, 2018, approximately 662,481 shares were available for grant under the 2015 Plan.

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Stock Options

The following table summarizes the stock option transactions for each of the years ended December 31, 2016, 2017 and 2018 (in thousands, except per share data):

Stock Options	Number of Options Outstanding	Weighted- average Exercise Price	Weighted average Remaining Contractual Life (in years)	Aggregate Intrinsic Value
Balance as of January 1, 2016	3,779	\$ 2.97	6.26	\$ 764
Granted	624	4.92		
Exercised	(555)	2.41		
Canceled and expired	(554)	3.26		
Balance as of December 31, 2016	3,294	\$ 3.38	7.23	\$ 5,301
Granted	184	8.99		
Exercised	(762)	3.25		
Canceled and expired	(50)	3.47		
Balance as of December 31, 2017	2,666	\$ 3.81	6.87	\$ 13,149
Granted	246	5.77		
Exercised	(238)	2.64		
Canceled and expired	(20)	4.40		
Balance as of December 31, 2018	2,654	\$ 4.09	6.28	\$ 2,720
Options vested as of December 31, 2018 and unvested options expected to vest, net of forfeitures	2,626	\$ 4.07	6.25	\$ 2,718
Options exercisable as of December 31, 2018	1,863	\$ 3.60	5.41	\$ 2,314

The options outstanding and exercisable as of December 31, 2018 were in the following exercise price ranges (in thousands, except per share data):

Range of Exercise Price	Options Outstanding as of December 31, 2018		Weighted average Remaining Contractual Life	Options Vested and Exercisable as of December 31, 2018	
	Shares	Weighted average Exercise Price		Shares	Weighted Average Exercise Price
\$ 2.14- \$ 2.14	21	\$ 2.14	5.33	21	\$ 2.14
\$ 2.18- \$ 2.18	593	\$ 2.18	6.84	420	\$ 2.18
\$ 2.29- \$ 2.36	374	\$ 2.32	5.13	374	\$ 2.32
\$ 2.47- \$ 2.91	378	\$ 2.69	5.05	360	\$ 2.69
\$ 4.79- \$ 4.79	129	\$ 4.79	2.82	129	\$ 4.79
\$ 5.21- \$ 5.21	487	\$ 5.21	7.82	251	\$ 5.21
\$ 5.61- \$ 5.77	325	\$ 5.73	8.21	80	\$ 5.61
\$ 5.83- \$ 7.82	163	\$ 5.85	1.59	163	\$ 5.85

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\$ 7.95-	\$ 7.95	60	\$ 7.95	8.08	29	\$ 7.95
\$ 9.50-	\$ 9.50	124	\$ 9.50	8.82	36	\$ 9.50
		2,654	\$ 4.09	6.28	1,863	\$ 3.60

There were 238,000, 762,000 and 555,000 options exercised in the years ended December 31, 2018, 2017 and 2016, respectively. The total intrinsic value of options exercised for the years ended December 31, 2018, 2017 and 2016, was \$666,000, \$4,030,000 and \$1,302,000, respectively.

As of December 31, 2018, the unamortized compensation costs related to unvested stock options granted to employees under our 2015 plan was approximately \$1.6 million, net of estimated forfeitures of \$167,000. These costs

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will be amortized on a straight-line basis over a weighted-average period of approximately 2.3 years and will be adjusted for subsequent changes in estimated forfeitures. We did not capitalize any stock based compensation to inventory as of December 31, 2018 and 2017, due to the immateriality of the amount.

Restricted Stock Awards

A summary of activity related to restricted stock awards for the years ended December 31, 2016, 2017 and 2018 is presented below (in thousands, except per share data):

Stock Awards	Shares	Weighted-Average Grant Date Fair Value
Non-vested as of January 1, 2016	546	\$ 2.39
Granted	136	\$ 4.66
Vested	(150)	\$ 2.34
Forfeited	(207)	\$ 2.55
Non-vested as of December 31, 2016	325	\$ 3.27
Granted	312	\$ 9.15
Vested	(157)	\$ 3.13
Forfeited	—	\$ —
Non-vested as of December 31, 2017	480	\$ 7.13
Granted	344	\$ 6.02
Vested	(181)	\$ 6.04
Forfeited	(10)	\$ 6.65
Non-vested as of December 31, 2018	633	\$ 6.85

Total fair value of stock awards vested during the years ended December 31, 2018, 2017 and 2016 was \$1.1 million, \$490,000 and \$351,000, respectively. As of December 31, 2018, we had \$3.9 million of unrecognized compensation expense related to restricted stock awards, which will be recognized over the weighted average period of 1.8 years.

Common Stock

The following number of shares of common stock were reserved and available for future issuance as of December 31, 2018 (in thousands, except per share data):

Options outstanding	2,654
Restricted stock awards outstanding	633
Stock available for future grant: 2015 Equity Incentive Plan	662
Total	3,949

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Stock-based Compensation

We recorded \$1.9 million, \$1.4 million and \$1.1 million of stock based compensation in our consolidated statements of operations for the years ended December 31, 2018, 2017 and 2016, respectively. The following table summarizes compensation costs related to our stock based compensation awards (in thousands, except per share data):

	Year Ended December 31,		
	2018	2017	2016
Stock based compensation in the form of employee stock options and restricted stock, included in:			
Cost of revenue	\$ 92	\$ 39	\$ 23
Selling, general and administrative	1,520	1,146	908
Research and development	313	220	165
Total stock-based compensation	1,925	1,405	1,096
Tax effect on stock-based compensation	—	—	—
Net effect on net income	\$ 1,925	\$ 1,405	\$ 1,096
Shares used in computing basic net income per share	39,049	37,444	32,139
Shares used in computing diluted net income per share	40,265	38,966	32,894
Effect on basic net income per share	\$ (0.05)	\$ (0.04)	\$ (0.03)
Effect on diluted net income per share	\$ (0.05)	\$ (0.04)	\$ (0.03)

We estimate the fair value of stock options using a Black Scholes valuation model. There were 246,000, 184,000 and 624,000 stock options granted with a weighted-average grant date fair value of \$2.74, \$3.67 and \$1.85 per share during 2018, 2017 and 2016, respectively. The fair value of options granted was estimated at the date of grant using the following weighted average assumptions:

	Year Ended December 31,		
	2018	2017	2016
Expected term (in years)	5.8	5.8	4.0
Volatility	46.6 %	46.5 %	46.5 %
Expected dividend	— %	— %	— %
Risk-free interest rate	3.09 %	2.10 %	1.47 %

The expected term for stock options is based on the observed historical option exercise behavior and post-vesting forfeitures of options by our employees, and the contractual term, the vesting period and the expected term of the outstanding options. Expected volatility is based on the historical volatility of our common stock. The dividend yield of zero is based on the fact that we have never paid cash dividends and have no present intention to pay cash dividends. The risk-free interest rates are taken from the Daily Federal Yield Curve Rates as of the grant dates as published by the Federal Reserve and represent the yields on actively traded Treasury securities for terms equal to the expected term of the options.

Retirement Savings Plan

We have a 401(k) Savings Plan (“Savings Plan”) which qualifies as a thrift plan under Section 401(k) of the Internal Revenue Code. All full-time U.S. employees are eligible to participate in the Savings Plan after 90 days from the date of hire. Employees may elect to reduce their current compensation by up to the statutory prescribed annual limit and have the amount of such reduction contributed to the 401(k) Plan. We provide matching to employee contributions up to 4% of the employees’ base pay if employees contribute at least 6% of their base pay. If the contribution rate is less than 6% of the base pay, the matching percentage is prorated. Our contributions to the Savings Plan were \$180,000, \$149,000 and \$133,000 for the years ended December 31, 2018, 2017 and 2016, respectively.

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Note 11. Guarantees

Indemnification Agreements

We have entered into indemnification agreements with our directors and officers that require us to indemnify our directors and officers against liabilities that may arise by reason of their status or service as directors or officers, other than liabilities arising from willful misconduct of a culpable nature; to advance their expenses incurred as a result of any proceeding against them as to which they could be indemnified; and to obtain directors' and officers' insurance if available on reasonable terms, which we currently have in place.

Product Warranty

We provide warranties for our products for a specific period of time, generally twelve months, against material defects. We provide for the estimated future costs of warranty obligations in cost of sales when the related revenue is recognized. The accrued warranty costs represent the best estimate at the time of sale of the total costs that we expect to incur to repair or replace product parts that fail while still under warranty. The amount of accrued estimated warranty costs are primarily based on historical experience as to product failures as well as current information on repair costs. On a quarterly basis, we review the accrued balances and update the historical warranty cost trends. The following table reflects the change in our warranty accrual which is included in "Accrued liabilities" on the consolidated balance sheets, during 2018 and 2017 (in thousands):

	Year Ended December 31,	
	2018	2017
Beginning accrued product warranty	\$ 133	\$ 251
Accruals for warranties issued	289	125
Adjustments related to pre-existing warranties including expirations and changes in estimates	87	(150)
Cost of warranty repair	(273)	(93)
Ending accrued product warranty	\$ 236	\$ 133

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Note 12. Income Taxes

Consolidated income before provision for income taxes includes non-U.S. income of approximately \$6.5 million, \$6.4 million and \$15.0 million for the years ended December 31, 2018, 2017 and 2016, respectively. We recorded a current tax provision of \$938,000, \$792,000 and \$733,000 for the years ended December 31, 2018, 2017 and 2016, respectively. The components of the provision for income taxes are summarized below (in thousands):

	Year Ended December 31,		
	2018	2017	2016
Current:			
Federal	\$ —	\$ —	\$ —
State	5	2	4
Foreign	933	790	729
Total current	938	792	733
Deferred:			
Federal	—	—	—
State	—	—	—
Total deferred	—	—	—
Total provision for income taxes	\$ 938	\$ 792	\$ 733

A reconciliation of the effective income tax rates and the U.S. statutory federal income tax rate is summarized below:

	Year Ended December 31,					
	2018		2017		2016	
Statutory federal income tax rate	21.0	%	35.0	%	35.0	%
State income taxes, net of federal tax benefits	—		—		—	
Valuation allowance	(2.6)		(139.5)		(7.1)	
Rate change	—		100.8		—	
Stock-based compensation	0.3		(10.4)		1.2	
Foreign tax rate differential	(11.4)		(10.3)		(12.2)	
Foreign tax incentives	(2.9)		(7.0)		(13.6)	
Dividend from unconsolidated affiliates	—		—		1.5	
Foreign income inclusion	2.6		55.6		—	
Section 78 gross up	—		11.7		—	
Foreign tax credit	—		(30.6)		—	
Tax effect in equity method loss or gain from unconsolidated affiliates	3.2		2.9		8.3	
Foreign-derived intangible income	(2.4)		—		—	
Other	0.1		(0.9)		(0.2)	
Effective tax rate	7.9	%	7.3	%	12.9	%

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Deferred tax assets and liabilities are summarized below (in thousands):

	As of December 31,	
	2018	2017
Deferred tax assets:		
Net operating loss	\$ 15,735	\$ 14,203
Accruals and reserves not yet deductible	2,100	3,133
Credits	1,685	4,809
	19,520	22,145
Deferred tax liabilities:		
Valuation of investment portfolio	—	—
	—	—
Net deferred tax assets	19,520	22,145
Valuation allowance	(19,520)	(22,145)
Net deferred tax assets	\$ —	\$ —

As of December 31, 2018, we have federal and state net operating loss (“NOL”) carryforwards of approximately \$64.3 million and \$0.3 million, respectively, which will expire beginning in 2022 and 2033, respectively. In addition, we have federal tax credit carryforwards of approximately \$1.7 million, which will expire beginning in 2027.

The deferred tax assets valuation allowance as of December 31, 2018 is attributed to U.S. federal, and state deferred tax assets, which result primarily from future deductible accruals, reserves, NOL carryforwards, and tax credit carryforwards. We believe that, based on a number of factors, the available objective evidence creates sufficient uncertainty regarding the realizability of the deferred tax assets such that a full valuation allowance has been recorded. These factors include our history of losses related to domestic operations, and the lack of carryback capacity to realize deferred tax assets. The valuation allowance decreased by \$2.6 million and \$46.3 million for the years ended December 31, 2018 and 2017, respectively, whereas the valuation allowance increased by \$2.7 million for the year ended December 31, 2016.

The China Enterprise Income Tax Law (“EIT”) imposes a single uniform income tax rate of 25% on all Chinese enterprises. Our subsidiaries in China have qualified for a preferential 15% tax rate that is available for High and New Technology Enterprises (“HTE”). In order to retain the preferential tax rate, we must meet certain operating conditions, satisfy certain product requirements, meet certain headcount requirements and maintain certain levels of research expenditures. We realized benefits from this 10% reduction in tax rate of \$764,000, \$599,000 and \$489,000 for 2018, 2017 and 2016, respectively. As of December 31, 2018, the favorable tax rate is still valid for the Company and it will stay the same for next year if there is no change of the business nature. The preferential tax rate that we enjoy could be modified or discontinued altogether at any time, which could materially and adversely affect our financial condition and results of operations.

Our subsidiaries in China also qualify for reduction in their taxable income in China for research and development (“R&D”) expenditures. Government pre-approval is required to claim R&D tax benefits. Any R&D claim is then submitted with the annual corporate income tax for the taxing authorities’ approval. We do not record such benefit until we receive the refund from the Chinese government. Our consolidated subsidiaries in China have enjoyed various tax holidays since 2000. Benefits under the tax holidays vary by jurisdiction.

Utilization of the NOL and R&D credit carryforwards may be subject to a substantial annual limitation due to ownership changes that might have occurred previously or that could occur in the future, as provided by Section 382

of the Internal Revenue Code of 1986 (“Section 382”), as well as similar state provisions. Ownership changes may limit the amount of NOL and tax credit carryforwards that can be utilized to offset future taxable income and tax, respectively. In general, an ownership change, as defined by Section 382, results from transactions increasing the ownership of certain shareholders or public groups in the stock of a corporation by more than 50 percentage points over a three-year period. If there is a change of control, utilization of our NOL or tax credit carryforwards would be subject to an annual limitation under Section 382. Any limitation may result in expiration of a portion of the NOL or research and development credit

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carryforwards before utilization. Subsequent ownership changes could further impact the limitation in future years. Until a Section 382 study is completed and any limitation known, no amounts are being presented as an uncertain tax position. A full valuation allowance has been provided against our NOL carryforwards and R&D credit carryforwards and, if an adjustment is required, this adjustment would be offset by an adjustment to the valuation allowance. Thus, there would be no net impact to the consolidated balance sheets or statements of operations if an adjustment were required.

We have completed the accounting associated with the December 22, 2017 enactment of the Tax Reform. The SEC had provided accounting and reporting guidance that allowed us to report provisional amounts within a measurement period up to one year from the enactment date. Complexities inherent in adopting the changes included additional guidance, interpretations of the law, and further analysis of data and tax positions. During 2018, we trueed up approximately \$3.1 million foreign tax credit related to the Tax Reform, due to the deferred tax assets are all under full valuation allowance, the true up has no direct tax impact.

During fiscal year 2018, 2017 and 2016, the amount of gross unrecognized tax benefits remains unchanged. The total amount of unrecognized tax benefits was \$14.6 million as of December 31, 2018 and 2017. The Company recognizes interest and penalties related to uncertain tax positions as part of the provision for income taxes. To date, such interest and penalties have not been material.

We comply with the laws, regulations, and filing requirements of all jurisdictions in which we conduct business. We regularly engage in discussions and negotiations with tax authorities regarding tax matters in various jurisdictions.

We file income tax returns in the U.S. federal, various states and foreign jurisdictions. Currently, there is no tax audit in any of the jurisdictions and we do not expect there will be any significant change to this.

A reconciliation of the beginning and ending amount of the gross unrecognized tax benefits is as follows (in thousands):

	Year Ended December 31,		
	2018	2017	2016
Gross unrecognized tax benefits balance at beginning of the year	\$ 14,557	\$ 14,557	\$ 14,557
Add:			
Additions based on tax positions related to the current year	—	—	—
Additions for tax positions of prior years	—	—	—
Less:			
Decrease related to lapse of statute of limitations	—	—	—
Gross unrecognized tax benefits balance at end of the year	\$ 14,557	\$ 14,557	\$ 14,557

Excluding the effects of recorded valuation allowances for deferred tax assets, \$14.6 million of the unrecognized tax benefit would favorably impact the effective tax rate in future periods if recognized.

Note 13. Net Income (Loss) per Share

Basic net income (loss) per share is computed using the weighted average number of common shares outstanding during the periods less shares of common stock subject to repurchase and non-vested stock awards. Diluted net income (loss) per share is computed using the weighted average number of common shares outstanding and potentially dilutive common shares outstanding during the periods. The dilutive effect of outstanding stock options and restricted stock awards is reflected in diluted earnings per share by application of the treasury stock method. Potentially dilutive common shares consist of common shares issuable upon the exercise of stock options. Potentially dilutive common shares are excluded in net loss periods, as their effect would be anti-dilutive.

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A reconciliation of the numerators and denominators of the basic and diluted net income (loss) per share calculations is as follows (in thousands, except per share data):

	Year ended December 31,		
	2018	2017	2016
Numerator:			
Net income attributable to AXT, Inc.	\$ 9,654	\$ 10,148	\$ 5,636
Less: Preferred stock dividends	(177)	(177)	(177)
Net income available to common stockholders	\$ 9,477	\$ 9,971	\$ 5,459
Denominator:			
Denominator for basic net income per share - weighted-average common shares	39,049	37,444	32,139
Effect of dilutive securities:			
Common stock options	1,106	1,339	596
Restricted stock awards	110	183	159
Denominator for dilutive net income per common shares	40,265	38,966	32,894
Basic net income per share:			
Net income attributable to AXT, Inc.	\$ 0.24	\$ 0.27	\$ 0.17
Net income to common stockholders	\$ 0.24	\$ 0.27	\$ 0.17
Diluted net income per share:			
Net income attributable to AXT, Inc.	\$ 0.24	\$ 0.26	\$ 0.17
Net income to common stockholders	\$ 0.24	\$ 0.26	\$ 0.17
Options excluded from diluted net income per share as the impact is anti-dilutive	266	86	779
Restricted stock excluded from diluted net income per share as the impact is anti-dilutive	227	63	15

Note 14. Segment Information and Foreign Operations

Segment Information

We operate in one segment for the design, development, manufacture and distribution of high-performance compound and single element semiconductor substrates and sale of raw materials integral to these substrates. In accordance with ASC topic 280, Segment Reporting, our chief operating decision maker has been identified as the Chief Executive Officer, who reviews operating results to make decisions about allocating resources and assessing performance for the Company. Since we operate in one segment, all financial segment and product line information can be found in the consolidated financial statements.

Product Information

The following table represents revenue amounts (in thousands) by product type:

Product Type:	Year Ended		
	December 31, 2018	2017	2016
Substrates	\$ 81,008	\$ 78,619	\$ 65,633
Raw Materials and Others	21,389	20,054	15,716
Total	\$ 102,397	\$ 98,673	\$ 81,349

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Geographical Information

The following table represents revenue amounts (in thousands) reported for products shipped to customers in the corresponding geographic region:

	Year Ended December 31,		
	2018	2017	2016
Geographical region:			
China	\$ 31,492	\$ 24,962	\$ 17,448
Europe (primarily Germany)	22,013	23,956	18,637
Taiwan	20,078	18,279	15,369
Japan	10,305	13,258	11,015
North America (primarily the United States)	10,021	8,352	8,084
Asia Pacific (excluding China, Taiwan and Japan)	8,488	9,866	10,796
Total	\$ 102,397	\$ 98,673	\$ 81,349

Long-lived assets consist primarily of property, plant and equipment, and are attributed to the geographic location in which they are located. Long-lived assets, net of depreciation, by geographic region were as follows (in thousands):

	As of December 31,	
	2018	2017
Long-lived assets by geographic region, net of depreciation:		
North America	\$ 445	\$ 1,410
China	81,835	45,120
	\$ 82,280	\$ 46,530

Note 15. Other (expense) income

The components of other (expense) income are summarized below (in thousands):

	Year Ended December 31,		
	2018	2017	2016
Foreign exchange gain (loss)	\$ 165	\$ (602)	\$ 232
Gain on available-for-sales securities	—	77	429
Other income (expense)	187	(28)	199
	\$ 352	\$ (553)	\$ 860

Note 16. Commitments and Contingencies

Legal Proceedings

From time to time we may be involved in judicial or administrative proceedings concerning matters arising in the ordinary course of business. We do not expect that any of these matters, individually or in the aggregate, will have a material adverse effect on our business, financial condition, cash flows or results of operations.

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Leases

We lease certain office space, warehouse facilities and equipment under long-term operating leases expiring at various dates through December 2025. The majority of our lease obligations relates to our lease agreement for the facility in Fremont, California with approximately 19,467 square feet which expires in 2020. Total rent expense under these operating leases were \$319,000, \$302,000 and \$331,000 for the years ended December 31, 2018, 2017 and 2016, respectively. Total minimum lease payments under these leases as of December 31, 2018 are summarized below (in thousands):

	Lease Payments
2019	\$ 198
2020	161
2021	9
2022	6
	\$ 374

Royalty Agreement

We entered into a royalty agreement with a competitor effective December 3, 2010 with a term of eight years, terminating December 31, 2018. We and our related companies are granted a worldwide, nonexclusive, royalty bearing, irrevocable license to certain patents for the term on the agreement. We shall pay up to \$7.0 million royalty payment over eight years that began in 2011 based on future royalty bearing sales. This agreement contains a clause that allows us to claim a credit, starting in 2013, in the event that the royalty bearing sales for the year is lower than a pre-determined amount set forth in this agreement. For the year ended December 31, 2018, royalty expense under this agreement was \$565,000, which was net of claim for credit of \$10,000. Royalty expense for year ended December 31, 2017 was \$526,000, which was net of claim for credit of \$49,000. Royalty expense under this agreement was \$447,000, which was net of claim for credit of \$128,000 for the year ended December 31, 2016. These expenses were included in cost of revenue. Sumitomo has asked that we renew this license and the need to do so is under review.

Land Purchase and Investment Agreement

We are in the process of relocating our gallium arsenide production line to Dingxing, China. In addition to a land rights and building purchase agreement that we entered into with a private real estate development company to acquire our new manufacturing facility, we also entered into a cooperation agreement with the Dingxing local government. In addition to pledging its full support and cooperation, the Dingxing local government will issue certain credits or rebates to us as we achieve certain milestones. We, in turn, agreed to hire local workers over time, pay taxes when due and eventually demonstrate a total investment of approximately \$90 million in value, assets and capital. The investment will include cash paid for the land and buildings, cash on deposit in our name at local banks, the gross value of new and used equipment (including future equipment that might be used for indium phosphide and germanium substrates production), the deemed value for our customer list or the end user of our substrates (for example, the end users of the 3-D sensing VCSELs), a deemed value for employment of local citizens, a deemed

value for our proprietary process technology, other intellectual property, other intangibles and additional items of value. There is no timeline or deadline by which this must be accomplished, rather it is a good faith covenant entered into between AXT and the Dingxing local government. Further, there is no specific penalty contemplated if either party breaches the agreement, however the agreement does state that each party has a right to seek from the other party compensation for losses. Under certain conditions, the Dingxing local government may purchase the land and building at the appraised value. We believe that such cooperation agreements are normal, customary and usual in China and that the future valuation is flexible. We have a similar agreement with the city of Kazuo, China, although on a smaller scale. The total investment targeted by AXT in Kazuo is approximately \$15 million in value, assets and capital.

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Note 17. Unaudited Quarterly Consolidated Financial Data

	Quarter			
	First	Second	Third	Fourth
	(in thousands, except per share data)			
2018:				
Revenue	\$ 24,419	\$ 27,120	\$ 28,626	\$ 22,232
Gross profit	9,573	11,010	10,614	5,850
Net income (loss) attributable to AXT, Inc	2,875	3,901	3,939	(1,061)
Net income (loss) attributable to AXT, Inc per share, basic	\$ 0.07	\$ 0.10	\$ 0.10	\$ (0.03)
Net income (loss) attributable to AXT, Inc per share, diluted	\$ 0.07	\$ 0.10	\$ 0.10	\$ (0.03)
2017:				
Revenue	\$ 20,616	\$ 23,557	\$ 28,168	\$ 26,332
Gross profit	6,288	7,256	11,133	9,798
Net income attributable to AXT, Inc	665	1,930	4,419	3,134
Net (loss) attributable to AXT, Inc per share, basic	\$ 0.02	\$ 0.05	\$ 0.11	\$ 0.08
Net (loss) attributable to AXT, Inc per share, diluted	\$ 0.02	\$ 0.05	\$ 0.11	\$ 0.08

Note 18. Restructuring Charges

In the second quarter of 2016, we restructured the operations of JiYa which resulted in a reduction in force of 28 positions that were no longer required to support production and operations. Accordingly, we recorded a restructuring charge of approximately \$226,000 related to the reduction in force for severance-related expenses. As of June 30, 2016, we had completed this restructuring plan and the reduction in force. We did not have any restructuring charges in 2018 and 2017.

Item 16. Form 10-K Summary

Not applicable.

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AXT, Inc.

EXHIBITS

TO

FORM 10-K ANNUAL REPORT

For the Year Ended December 31, 2018

Exhibit Number	Description
3.1(1)	<u>Restated Certificate of Incorporation</u>
3.2(2)	<u>Certificate of Amendment of Certificate of Incorporation</u>
3.3(3)	<u>Certificate of Amendment to the Restated Certificate of Incorporation</u>
3.4(4)	<u>Certificate of Designation, Preferences and Rights of Series A Preferred Stock (which is incorporated herein by reference to Exhibit 2.1 to the registrant's form 8-K dated May 28, 1999).</u>
3.5(5)	<u>Second Amended and Restated By Laws</u>
3.6(6)	<u>Amended and Restated Section 5.1 of Article V of the Second Amended and Restated Bylaws of AXT, Inc.</u>
3.7(7)	<u>Certificate of Amendment to By Laws</u>
10.1(8)*	<u>Form of Indemnification Agreement for directors and officers</u>
10.3(9)**	<u>6-inch Supply Agreement dated December 31, 2008 between AXT, Inc. and IOE plc</u>
10.4(10)**	<u>4-inch Supply Agreement dated December 31, 2008 between AXT, Inc. and IOE plc</u>
10.5(11)*	<u>2007 Equity Incentive Plan (amended December 8, 2008)</u>
10.6(12)*	<u>Forms of agreements under the 2007 Equity Incentive Plan</u>
10.7(13)*	<u>Amended and Restated Employment Offer Letter between the Company and Dr. Morris S. Young dated December 4, 2012</u>
10.8(14)*	<u>Employment Letter Agreement between the Company and Mr. Gary L. Fischer</u>
10.9(15)*	<u>2015 Equity Incentive Plan</u>
10.10(16)*	<u>Executive Incentive Plan</u>
10.11(17)*	<u>Credit Agreement, dated as of November 2, 2018, by and between AXT, Inc. and Wells Fargo Bank, National Association</u>
12.1	<u>Computation of Ratio of Earnings to Fixed Charges</u>
21.1	<u>List of Subsidiaries</u>
23.1	<u>Consent of Independent Registered Public Accounting Firm, BPM LLP</u>
24.1	Power of Attorney (see signature page)
31.1	<u>Certification by principal executive officer pursuant to Section 302 of the Sarbanes Oxley Act of 2002</u>
31.2	<u>Certification by principal financial officer pursuant to Section 302 of the Sarbanes Oxley Act of 2002</u>
32.1	<u>Certification by Chief Executive Officer Pursuant to 18 U.S.C. Section 1350, as adopted Pursuant to Section 906 of the Sarbanes Oxley Act of 2002</u>
32.2	<u>Certification by Chief Financial Officer Pursuant to 18 U.S.C. Section 1350, as adopted Pursuant to Section 906 of the Sarbanes Oxley Act of 2002</u>
101.INS	XBRL Instance.
101.SCH	XBRL Taxonomy Extension Schema.
101.CAL	XBRL Taxonomy Extension Calculation Linkbase.
101.DEF	XBRL Taxonomy Extension Definition Linkbase.
101.LAB	XBRL Taxonomy Extension Label Linkbase.

101.PRE XBRL Taxonomy Extension Presentation Linkbase.

- (1) Incorporated by reference to exhibit 3.1 to registrant's Form 10-K filed with the SEC on March 31, 1999.
- (2) Incorporated by reference to exhibit 3.1 to registrant's Form 10-Q filed with the SEC on August 14, 2000.
- (3) Incorporated by reference to exhibit 3.4 to registrant's Form 10-Q filed with SEC on August 5, 2004.

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- (4) Incorporated by reference to exhibit 3.1 to registrant's Form 8-K filed with the SEC on June 14, 1999.
- (5) Incorporated by reference to exhibit 3.4 to registrant's Form 8-K filed with the SEC on May 30, 2001.
- (6) Incorporated by reference to exhibit 99.2 to registrant's Form 8-K filed with the SEC on August 1, 2007.
- (7) Incorporated by reference to exhibit 3.1 to registrant's Form 8-K filed with the SEC on October 26, 2010.
- (8) Incorporated by reference to exhibit 10.1 to registrant's Form 8-K filed with the SEC on October 31, 2014.
- (9) Incorporated by reference to exhibit 10.29 to registrant's Form 8-K filed with the SEC on January 5, 2009.
- (10) Incorporated by reference to exhibit 10.30 to registrant's Form 8-K filed with the SEC on January 5, 2009.
- (11) Incorporated by reference to exhibit 10.31 to registrant's Form 10-K filed with the SEC on March 31, 2009.
- (12) Incorporated by reference to exhibit 10.20 to registrant's Form 10-K filed with the SEC on March 22, 2010.
- (13) Incorporated by reference to exhibit 10.1 to registrant's Form 8-K filed with the SEC on December 4, 2012.
- (14) Incorporated by reference to exhibit 10.1 to registrant's Form 8-K filed with the SEC on August 12, 2014.
- (15) Incorporated by reference to appendix A to the registrant's Definitive Proxy Statement on Schedule 14A filed with the SEC on April 8, 2015.
- (16) Incorporated by reference to exhibit 10.1 to registrant's Form 8-K filed with the SEC on February 26, 2016.
- (17) Incorporated by reference to exhibit 10.1 registrant's Form 8-K filed with the SEC on November 9, 2018.

*Management contract or compensatory plan.

**Confidential treatment has been requested of the SEC for portions of the exhibit.

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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, thereto duly authorized.

AXT, Inc.

By: /s/ GARY L. FISCHER
Chief Financial Officer and Corporate Secretary
(Principal Financial Officer)

Date: March 11, 2019

POWER OF ATTORNEY

KNOW ALL PERSONS BY THESE PRESENTS, that each person whose signature appears below hereby constitutes and appoints Morris S. Young and Gary L. Fischer, and each of them, his true and lawful attorney-in-fact and agent, with full power of substitution, each with power to act alone, to sign and execute on behalf of the undersigned any and all amendments to this Report on Form 10-K, and to perform any acts necessary in order to file the same, with all exhibits thereto and other documents in connection therewith with the Securities and Exchange Commission, granting unto said attorney-in-fact and agent full power and authority to do and perform each and every act and thing requested and necessary to be done in connection therewith, as fully to all intents and purposes as he might or could do in person, hereby ratifying and confirming all that said attorney-in-fact and agent, or their or his or her substitutes, shall do or cause to be done by virtue hereof.

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 and on the dates indicated.

Signature	Title	Date
/s/ MORRIS S. YOUNG Morris S. Young	Chief Executive Officer and Director (Principal Executive Officer)	March 11, 2019
/s/ GARY L. FISCHER Gary L. Fischer	Chief Financial Officer and Corporate Secretary (Principal Financial Officer and Principal Accounting Officer)	March 11, 2019
/s/ JESSE CHEN Jesse Chen	Chairman of the Board of Directors	March 11, 2019
/s/ DAVID C. CHANG David C. Chang	Director	March 11, 2019
/s/ LEONARD LEBLANC Leonard LeBlanc	Director	March 11, 2019

