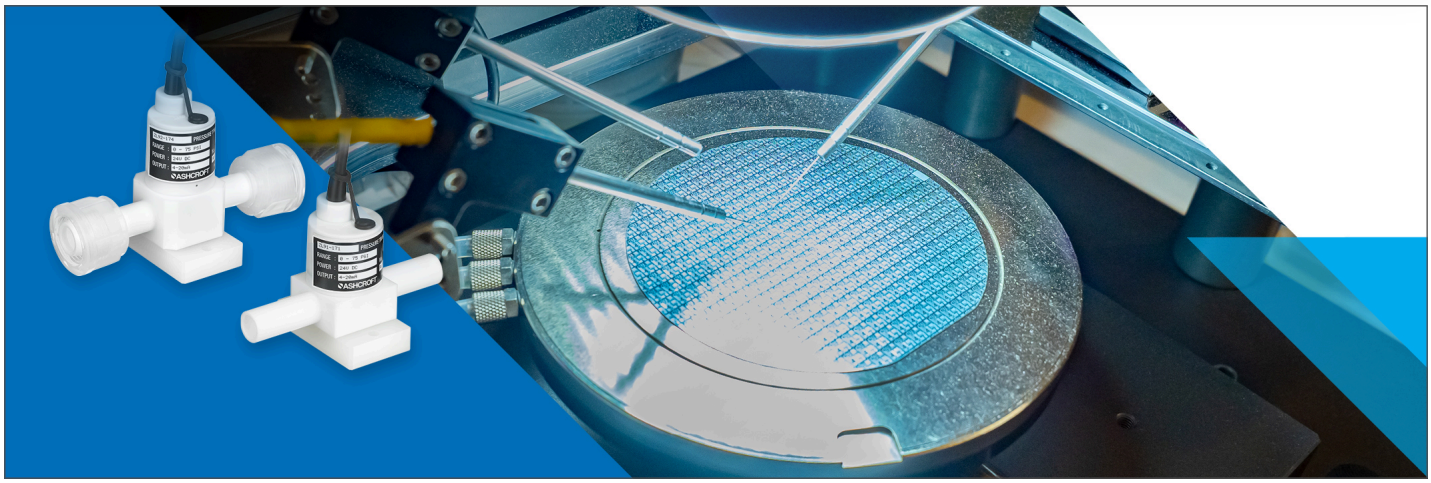

By: Adam Freyler, VP of Sales and Marketing (Americas) on February 12th, 2024

How do I select a pressure transducer for Semiconductor UHP liquid applications?

PRESSURE TRANSDUCERS | SEMICONDUCTOR | SEMICONDUCTOR INDUSTRY

Pressure sensors, including pressure transducers and pressure transmitters, are a critical aspect of semiconductor manufacturing. These instruments measure pressure to control the flow and distribution of ultrahigh purity (UHP) gases and liquids safely and effectively throughout the production process.

In my last article about transducers for semiconductor UHP gas applications, I explained how Ashcroft and our parent company Nagano Keiki Co. LTD, have been providing pressure and temperature instrumentation to semiconductor manufacturing customers globally for decades. This piece will provide more insight into the liquid process of semiconductor manufacturing and review the pressure monitoring features to look for in instruments that are designed to perform well in these complex processes.

When you are done reading, I hope you will have a better understanding of the use of UHP fluids in semiconductor applications and the solutions employed to accurately measure pressure. You will also find related articles and guides that you can use as references for this evolving topic.

The semiconductor process – fluid/liquids.

Semiconductor manufacturing is a highly complex process that converts a large blank silicon wafer into 100's to 1000's of individual microelectronic chips. Silicon starts as 99.99% pure laboratory-grown silicon ingots 200 – 300 mm (7.9 - 11.8 in.) in diameter and is sliced into wafers well under 1 mm (0.04 in.) in thickness.

The process involves layering materials onto the wafer, forming pathways and junctions that enable the flow and storage of electronic data. Exceptional precision is paramount to eliminate contamination at the atomic level and to maintain the purity of each device.

Three primary steps in liquid semiconductor manufacturing.

1. Polish the wafer.

To achieve the desired flatness at an atomic level, wafers in semiconductor manufacturing undergo a meticulous cleaning and polishing process. This involves using a technique called Chemical Mechanical Planarization (CMP), where a chemical slurry is applied to the wafer's surface to both chemically and abrasively remove any material. The slurry, which can be alkaline or acidic and contains nanoscale particles, plays a crucial role in eliminating impurities, particularly metals, to prevent surface defects on the wafer.

To ensure the effectiveness of the CMP process, all surfaces that come into contact with the slurry must be able to withstand abrasion, chemical breakdown, and leaching. This is where pressure transducers come in. By incorporating high-purity grades of fluoropolymers like Teflon™, PTFE, or PFA, in their construction materials, these transducers can meet the challenge of withstanding the harsh conditions of semiconductor manufacturing.

However, using fluoropolymers in pressure transducers poses a challenge due to their relatively poor mechanical properties for precise pressure measurement. To overcome this, a clever method combines a PTFE/PFA diaphragm in contact with the fluid, which is bonded to a ceramic sensor element. This combination leverages the outstanding properties of both materials, resulting in a precise and reliable measurement device for this specific application.

2. Use wet etching to remove material and pattern the wafer.

During this stage of the semiconductor manufacturing process, a precise technique is used to selectively remove specific portions of the semiconductor material to define the desired structure or pattern on the blank wafer.

To achieve the desired outcome, the wet etching process employs highly potent alkalis or acids. Some notable examples include Potassium Hydroxide (KOH), Tetramethylammonium hydroxide (TMAH), Hydrochloric Acid (HCL), Hydrofluoric Acid (HF), and Nitric Acid (HNO3). Successfully handling these liquids poses a challenge due to their capability to extract impurities present on the surface of a material, as well as permeating the material itself.

3. Clean the wafer.

To effectively clean a wafer after wet etching requires the removal of the etching chemicals as well as any stray particles on the water surface. This cleaning process generally involves the use of ultrapure water. The requirements for water to be considered "ultrapure" in the semiconductor industry are staggering, yet necessary, to clean and not contribute to contamination. Huge amounts of ultrapure water are needed, with a typical semiconductor fab using more than 2 million gallons / 8 million liters per day.

The standards for ultrapure water, outlined in SEMI F63 and ASTM D5127, require water to be ultrafiltered to a level that the water becomes a quite aggressive solvent and thus requiring the materials used in the process piping, controls and measurement devices to be exceptionally pure.

Pressure transducer considerations for semiconductor manufacturing.

Due to the harsh nature of semiconductor liquid applications, equipment and instruments like the Ashcroft® ZL91 Fluoropolymer Pressure Transducer must meet certain requirements to be used in these liquid processes.

Use high-quality material.

The material used in the construction of pressure instruments needs to be extremely high quality and compatible with the process media. In liquid applications, high-purity grades of fluoropolymers such as polytetrafluoroethylene and perfluoroalkoxy (PTFE/PFA) are commonly used due to their exceptional chemical resistance and prevention of contamination.

Offer durable, accurate and repeatable features.

When it comes to the best transducers for the process of semiconductor manufacturing, many of the same features are important for liquid and gas processes. Here are a few other features that are important for gas and liquid applications:

Repeatability - When purchasing a pressure transducer for semiconductor manufacturing, it's important to trust the measurement your instrument is providing. Ideally, whenever you test the pressure with the same tool, you want a device that will give you a consistent reading every time with no need for zero or span adjustment.

Durability - Shock, vibration, pressure spikes and pulsation can all create challenges for semiconductor operations. If not appropriately designed, pressure transducers can be damaged under harsh operating environments. The best options in this situation are the transducers that are built to withstand rugged conditions.

Accuracy – You'll also want to confirm the pressure sensor you choose meets the minimum requirements of your specific application. To be sure you have the most accurate measurement, look at the technology the instrument uses for reading pressure.

Some instruments offer a ±1% of span accuracy out of the box with zero and span setting errors already included in the specification. This means the unit is ready to be installed with no additional calibration adjustments needed.

Stay informed. Changes are coming.

Artificial Intelligence (AI), Autonomous driving, the Internet of Things (IoT), and other technology advancements guarantee one thing: semiconductor manufacturing will continue to evolve. Over the next few years, you can expect to see robust growth in the global semiconductor industry. This will challenge semiconductor suppliers to increase transistor density, improve reliability and reduce production and purchasing costs.

Stay current on the latest trends, innovations and the products that best support its stringent requirements. Here are a few articles you may have missed on the subject:

- How Do I Select a PressureTransducer for Semiconductor UHP Gas Applications?
- Product Review: ZL91 and ZL92 Pressure Transducer for Semiconductor Applications

If you would like more information on selecting high-purity pressure instruments for your semiconductor application, check out our product page, or download our free guide. Feel free to contact one of our product

experts with any questions you have.

About Adam Freyler, VP of Sales and Marketing (Americas)

Adam has been our Vice President of Sales and Marketing for the Americas since 2014, leading the company's sales and marketing teams in the Americas and is responsible for product strategy and driving sales growth in this market. Prior to joining the executive team, Adam was responsible for the sales and marketing of our electronic products. His previous experience includes 10 years in the industrial sensor business including roles in sales management, marketing and engineering at GE Druck and Gems Sensors. Adam earned his B.S. in Physics from the University of Maryland. Adam is an enthusiastic football fan and enjoys fishing, kayaking and spending time outdoors with his family.