Pure Water and Process Analytics for the Semiconductor Industry
Mettler-Toledo Thornton – providing measurement solutions.

Forty years ago, Thornton designed and manufactured the original analog resistivity meter for high purity water, which was initially branded under the Balsbaugh name. Thornton later pioneered microprocessor-based resistivity instrumentation with the first computed high purity temperature compensation in this new, demanding and innovative industry. Over the years, Thornton has become the resistivity measurement standard in the semiconductor manufacturing industry. Thornton 770MAX and 200 Series instruments are specified in the majority of semiconductor manufacturing facilities worldwide to monitor and control ultra-pure water systems.

Thornton has intimate knowledge of critical measurements needed for ultrapure water production. Our expansive measurement capabilities mean Thornton products are used throughout a plant’s complete water cycle in areas such as wafer processing tools, recycle/reclaim, waste treatment and various facility operations.

Today Thornton continues to provide innovative solutions, offering expanded measurement capabilities and a greater array of products to meet global microelectronics industry requirements. As part of the Mettler-Toledo Process Analytics Group, Thornton has gained world-class technology in the areas of pH, ORP and dissolved oxygen measurement. Our expanded global support infrastructure provides local sales and service for all Thornton products in many regions around the world.

Thornton Industry Participation

As a technical leader in pure water measurements, Thornton staff members participate in the following semiconductor and microelectronics-related organizations and conferences:

• ASTM D19 Water Committee, Task Group Chairman
• Semiconductor Pure Water & Chemicals Conference, Committee Member
• SEMI Member & Ultrapure Water Task Force, Participant
• Ultrapure Water Conference, Participant and featured Industry Expert

In addition, Thornton shares its years of measurement experience and industry knowledge by offering on-site technical training sessions that provide valuable product and application information to users. A wide variety of curriculums are available and are often tailored to specific needs.
Capabilities to meet the specific needs of the Semiconductor manufacturer.

- **Make-up Water**
  - Primary UPW Make-Up System (UPW Production & Distribution)

- **Evaporation**
  - Facility Operations (Boilers, Scrubbers, Cooling Towers)

- **Recycle**
  - Fab Drains (Collection, Segregation)

- **Waste Water Treatment**

- **Fab UPW Utilization**
  - (Wet Benches, Wafer Tools)

- **Reclaim**
Instrumentation designed for exacting industry requirements.

Thornton’s line of instruments demonstrate proven performance far beyond ultrapure water measurement applications and are found in many areas throughout today’s semiconductor facility. Innovative instrument technology allows us to offer many application specific features on all standard products. This provides end-users with the flexibility to configure a measurement system to their specific process needs. Our multi-channel and multi-parameter instrument platforms are designed with industry applications and unit processes in mind. The key to this concept is the ability to mix and match different measurement parameters on a single instrument, while maintaining individual measurement quality and performance.

The 770MAX is Thornton’s most advanced instrument for on-line measurement. It offers six-channel multiparameter measurement capability for resistivity/conductivity, TOC, pH, ORP, dissolved oxygen and temperature plus flow, pressure and level. The configuration flexibility of the 770MAX is unmatched, providing a total of 16 measurements from the 6 input channels with unique features such as specialized temperature compensation modes and derived measurements.

The 200 Series, comprised of the 200CR, 200pH, 200FLOW, 200CRS and 2000 instruments, provide two channel measurement of resistivity/conductivity, pH, ORP, dissolved oxygen, plus temperature. The 200 Flow provides up to four channels of flow measurement using a variety of sensor options.

Thornton’s 200/2000 and 770MAX measurement systems provide outstanding performance to monitor and control membrane-based filtration skids and other unit processes used to produce UPW. Additionally they are used in wafer processing tools, spent UPW water processes such as recycle/reclaim, waste neutralization and other facility operations such as scrubbers, cooling towers and boilers.
Continuous online TOC monitoring to measure critical organic levels.

Studies have demonstrated that even trace levels of TOC can negatively affect wafer production yields. TOC is among the list of critical parameters monitored throughout many locations in a semiconductor manufacturing facility. Extremely low levels of organics, down to the sub part-per-billion range, are required by most semiconductor fabs and foundries. Additionally, there is an increasing need to monitor TOC levels of spent rinse waters slated for reuse.

The all new 5000TOC Sensor provides continuous monitoring of total organic levels in pure and ultrapure water applications. The sensor’s compact, industrial design is easily integrated into UPW make-up systems, distribution loops, and other unit processes. The sensor can be wall or pipe mounted, making it ideally suited for process monitoring in these environments. As part of the 770MAX family of smart sensors, installation and setup are fast and simple. The combination of innovative sensor technology and 770MAX multiparameter analyzer transmitter capabilities makes the 5000TOC measurement system a powerful process monitoring tool.

Another TOC measurement option is Thornton’s 550TOC Analyzer. This portable unit uses proven UV technology to rapidly measure TOC in pure and ultrapure water applications. It can be used throughout the microelectronics facility to monitor TOC levels in UPW make-up processes and final polishers, wet bench processes, UPW points of distribution and spent rinse water recycle applications.

Unique benefits of both the 5000TOC Sensor and the 550TOC Analyzer include continuous online monitoring, point-of-use and portable monitoring capability, no reagents or chemicals, and no moving parts.
Mix and match sensors offer accurate, reliable options for every measurement parameter.

**Resistivity/Conductivity**
Thornton resistivity instrumentation is a semiconductor standard for measuring the quality of pure and ultrapure water. Our resistivity and conductivity sensors offer unmatched versatility and reliability. Each sensor is supplied with individually calibrated and certified cell constants as well as temperature elements, traceable to ASTM and NIST standards from our ISO9001-certified factory.

Our line of sensors includes 2-electrode, 4-electrode and inductive technologies to fit a wide range of measurement applications. All designs incorporate a variety of fitting styles and material options to meet specific requirements.

**pH/ORP**
Ultrapure water and high purity chemical mixtures are used to etch and clean wafer surfaces. Characteristics of spent rinse waters from these processes include low-to-moderate conductivity and TOC levels and varied pH levels. pH measurement is often required to control how these fluids are handled.

Under these conditions, pH measurement is a challenge. Thornton’s pHure Sensor™ provides reliable pure water measurements using this specialized electrode with self-pressurized gel reference, low resistance glass membrane, integral temperature compensator and convenient VP connector.

Semiconductor manufacturing processes contain numerous wafer cleaning and etching steps where varied concentrations of Hydrofluoric Acid (HF) are used. Additionally, the spent fluoride-containing rinsewaters are difficult to manage.

The Mettler-Toledo Thornton HF-resistant pH sensor offers both the benefit of greater accuracy and extended service life in these applications. This sensor uses a proprietary fluoride-resistant glass membrane, robust XEROLYT® PLUS reference system and integral temperature compensator to achieve this level of performance. Extended sensor life provides an added benefit to the overall cost of operating these treatment trains.

**Dissolved Oxygen**
Industry guidelines recommend that dissolved oxygen levels be reduced and maintained at very low levels to limit effects on wafer manufacturing processes. Unit processes such as degassification or deaeration can drive oxygen content to very low levels during the manufacture of ultrapure water. DO measurements provide assurance that these processes are working effectively. Some wafer processing steps require DO levels in the single digit part-per-billion range. This safeguards against potentially detrimental effects to wafer surfaces and oxide layers.

Thornton’s high-performance DO sensor provides highly accurate ppb measurements plus exceptionally fast downscale response of 98% in 90 seconds. It is ideal for monitoring the manufacture and distribution of ultrapure water and other wet processes.

**Flow Rate**
Wafer cleaning tools used in semiconductor chip manufacturing processes—such as photoresist strip and post-ash clean, oxide etch, nitride etch, and wafer reclaim—require accurate flow measurement for the transport of ultrapure water, chemicals, or combinations of both. Flowrate, and the amount of fluids used, are critical to efficient wafer tool operation.

The 317 Series PFA Vortex flowmeter is ideally suited for this application. A molded PFA body offers excellent thermal and chemical resistant properties. No moving parts assure there is no particle shedding. FloRetek style end connections, a standard for semiconductor tool manufacturers, are also available on this sensor.
Outstanding training and technical services empower the Thornton user.

On-Site Instrument Operation & Calibration Training Workshops
Thornton’s Operator Training Courses are tailored to each customer’s requirements. The course is conducted in a classroom setting where interaction between instructor and participants is encouraged. Each attendee is supplied with material detailing the course content. Instruments are provided for hands-on participation. The areas covered in this training program focus on Thornton instrumentation, calibration, and maintenance specific to your facility. Additional technical topics may be added or substituted as requested.

Traceable Instrument Calibration
Thornton offers instrument calibration and validation services traceable to national standards, industry guidelines, and/or regulatory requirements. Services using factory trained technicians are available at our facilities in Bedford, Massachusetts or on-site at your location. Each calibrated/validated instrument is supplied with the appropriate calibration documents.

Specialized Conductivity Calibrations
Choose one of seven unique conductivity calibrations to fit your application needs—from standard calibrations to unique, customer-specified temperature and ASTM verification points. For optimal system accuracy, we offer system calibrations, where instruments and sensors are calibrated together.

Service & Calibration Contracts
A Thornton representative will provide on-site service for items covered under the agreement. These services include, but are not limited to:

- Calibration/Validation of equipment or system
- Issuance of appropriate documentation
- Identification and verification of all software revisions
- Minor repairs or adjustment of instruments at a discounted labor rate
- Installation and start-up support services
Worldwide offices ensure prompt, local sales support.

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