

Sievers* instruments for microelectronics applications

industry challenges

Consistent ultrapure water (UPW) production is critical for microelectronics manufacturing and helps protect product quality. In addition to essential UPW monitoring, microelectronics facilities are also challenged to react quickly to any out of trend results and demonstrate effective troubleshooting and process control. Other areas of concern include ensuring chemical purity to improve process performance and batch yield, and monitoring waste and reclaim streams.

Microelectronics manufacturers work within a wide range of organic contaminants and experience a variety of challenges including:

- Low parts-per-million (ppm) concentrations in feedwater and high purity process chemicals
- Parts-per-trillion (ppt) concentrations prior to final polishing
- Complex sample matrices of reclaim and wastewater applications
- A critical need to monitor harmful particles, including colloidal silica

solution

SUEZ, through its Sievers Total Organic Carbon (TOC) instruments and UPW Boron Analyzer, provides analytical solutions for every step of the microelectronic manufacturing process. Given their broad analytical range and application versatility, Sievers TOC Analyzers are used for UPW, process chemical purity, reclaim and wastewater treatment monitoring. The Sievers UPW Boron Analyzer provides silica control and resin bed management by detecting an increase in boron, as boron elutes off resin beds prior to silica.

comprehensive and flexible monitoring options

There are two detection technologies commonly used to monitor TOC in low-level microelectronic applications - Membrane Conductometric (MC) and

Direct Conductometric (DC). The SUEZ portfolio offers both technologies, in addition to wet chemical oxidation for more complex matrices like process chemicals and waste streams.

The following instruments and offerings are available:

- The Sievers M9e, M500e, and 500 RLe TOC Analyzers utilize Sievers MC detection technology
 - Sievers MC technology eliminates false positives and false negatives that result from halogenated organics and amines present in most UPW systems
- The Sievers CheckPointe TOC Sensor utilizes DC technology
 - Offers an economical option for non-critical UPW monitoring points
 - To be used as a rapid diagnostic and troubleshooting tool
- The Sievers InnovOx TOC Analyzers utilize Super Critical Water Oxidation (SCWO) with non-dispersive infrared (NDIR) detection
 - Accurately and reliably measure trace organics in concentrated acids, bases, and pure chemicals
 - Monitor wastewater streams and brine up to 30%

application needs and Sievers solutions

Feed, UPW and Reclaim System Monitoring

The Sievers M9e Online and Portable TOC Analyzers are designed for the most complex water systems and applications. These analyzers offer a wide analytical range of 0.03 ppb to 50 ppm and use MC technology to accurately measure TOC levels in system feed water, reverse osmosis product, and final product water. With the optional Turbo mode's four-second analysis time, the Sievers M9e Analyzers are the ideal troubleshooting tool for reclaim applications.

The Sievers M9e offers:

- Instrument-to-instrument matching
- Low-level stability in low-TOC UPW applications
- Automated operations, such as calibration, verification, and data analysis
- 12-month calibration stability
- Advanced autozeroing for accuracy and precision at ultrapure levels

UPW / Polish Loop Monitoring

The Sievers M500e and previous generation 500 RLe TOC Analyzers are designed to monitor low-level TOC measurements. Offering an operating range of 0.03 ppb to 2.5 ppm, these analyzers provide the lowest limit of detection for reagentless, online UPW TOC analyzers.

The Sievers M500e and 500 RLe:

- Detect problematic organic compounds, such as organic acids and organic nitrogen compounds, that present significant risk to fabrication operations^{1,2}
- Operate in low dissolved oxygen (DO) and hydrogenated water systems

In 2020, SUEZ launched the Sievers M500e, the next generation 500 RLe with improvements including:

- 50% reduction in rinse-down time - units can be put into production faster and back to operational following on-site low-level calibration (250 ppb) or annual maintenance
- 10" touchscreen to enable faster and intuitive setup and operation.
- Digital upgrades such as remote access, WiFi capabilities, improved data transfer and management options, and step-by-step wizards
- Improved conductivity range (0.01-800 $\mu\text{S}/\text{cm}$) which can also be displayed as resistivity
- 100 ppb verification protocol using isopropanol (IPA)
- Adaptive autozero to automatically predict frequency based on prior results

Another essential instrument for microelectronics applications is the Sievers UPW Boron Analyzer. The Sievers Boron Analyzer predicts mixed-bed exhaustion, optimizes EDI performance and controls polishing loop boron levels. The Sievers Boron Analyzer detects an increase in boron prior to silica release, making it useful to prevent the leakage of silica into ultrapure water. The Sievers Boron Analyzer can significantly reduce operating expenses and maintain quality in UPW systems.

UPW Water System Diagnostics and Troubleshooting

The Sievers CheckPointe is an ideal instrument for problem-solving and diagnostics with an analytical range of 0.05 to 1,000 ppb. It features ultra-portability (3.6 kg) using Direct Conductometric methodology and is:

- Able to accept samples from pressurized or non-pressurized sources
- Used at distribution points, fab tools or any point where permanent monitoring has not been established
- Calibrated to a reference TOC instrument, allowing excellent low TOC level sensor-to-sensor matching

Chemical & Wastewater Purity

It is critical to control TOC in process chemicals such as peroxide, sodium hydroxide, ammonium hydroxide, sulfuric acid, and other etching/plating chemicals - to deliver improvements in process performance and batch yield. The Sievers InnovOx TOC Analyzer is ideal for this as well as for the monitoring of organics in waste and reclaim streams.

Sievers InnovOx helps:

- Drive smarter decisions for compliance and treatment
- Deliver real-time direct carbon measurement as opposed to indirect oxygen demand tests
- Handle complex matrices with its SCWO methodology

Summary of Sievers instruments and applications for microelectronics manufacturing

	Models	Range	Analysis Time	Municipal Feed	Applications				
					UPW	Polishing	Reclaim	Diagnostics	Chemicals & WW
TOC – Membrane Conductometric									
M9e	Online & Portable	0.03 ppb – 50 ppm	2 min	✓	✓	✓	✓	✓	
M9e Turbo	Online & Portable	0.20 ppb – 10 ppm	4 sec	✓	✓		✓	✓	
500 RLe	Online	0.03 ppb – 2.5 ppm	6 min		✓	✓			
M500e	Online	0.03 ppb – 2.5 ppm	3 min		✓	✓			
TOC - Direct Conductometric									
CheckPointe	Online & Portable	0.05 ppb – 1 ppm	15 sec					✓	
TOC - Super Critical Water Oxidation									
InnovOx	Lab & Online	50 ppb – 50,000 ppm	5-15 min				✓	✓	✓
Boron									
UPW Boron	Online	15 ppt – 20 ppb	5-15 min		✓	✓			

References

1 Godec, Richard D., "Monitoring and Controlling UPW Organic Nitrogen Contamination to Improve Immersion Photolithography Process Control." Presented at ULTRAPURE WATER Conference, Portland, OR, November 2011, Tall Oaks Publishing, Inc.

2 Godec, Richard D., "The Performance Comparison of Ultrapure Water TOC Analyzers using an Automated Standard Addition Apparatus." Published and copyrighted by Semiconductor Pure Water and Chemical Conference, 2000 Proceedings.

3. Dunn R., "New Analytical Technique Promotes Elimination of Silica in Feed, Steam and Condensate Systems."

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