Sievers* Boron Ultra Online UPW Analyzer

VEOLIA

CONTINUOUS, ONLINE MONITORING OF PARTS-PER-TRILLION LEVELS OF BORON

Overview

The revolutionary Sievers Boron Ultra Analyzer is the latest generation of Sievers boron detection analyzers - the only instruments to enable continuous, unattended online monitoring of parts-per-trillion (ppt) levels of boron in ultrapure water (UPW) applications. The Sievers Boron Ultra UPW Analyzer was developed in cooperation with semiconductor manufacturers to control contamination in UPW such as colloidal silica. As semiconductor chip dimensions continue to shrink, early detection of contamination is increasingly critical. Boron Ultra is used to minimize and control the leakage of colloidal and ionic silica from ion removal processes like mixed-bed ion exchange and electrodeionization (EDI) to improve chip yield. Additionally, it is used to control the deionization process to meet the International Roadmap for Devices and Systems (IRDS) 50 ppt boron limit in semiconductor UPW. It is designed specifically to meet the needs of facility managers, UPW system owners, and UPW process control engineers and technicians.

Online Performance

Possessing the parts-per-trillion sensitivity of ICP-MS[1] (Figures 1 and 2), the Boron Ultra Analyzer enables effective control of silica and boron, the minimization of colloidal and ionic reactive silica, and adherence to IRDS-recommended ionic control within primary and polish loops.

Capable of up to twenty realtime data points per hour, the analyzer allows proactive, high-resolution control of ionic excursions by providing process engineers the ability to detect ionic trends far in advance of other ionic detection methods including ICP-MS and NRM detection of silica.

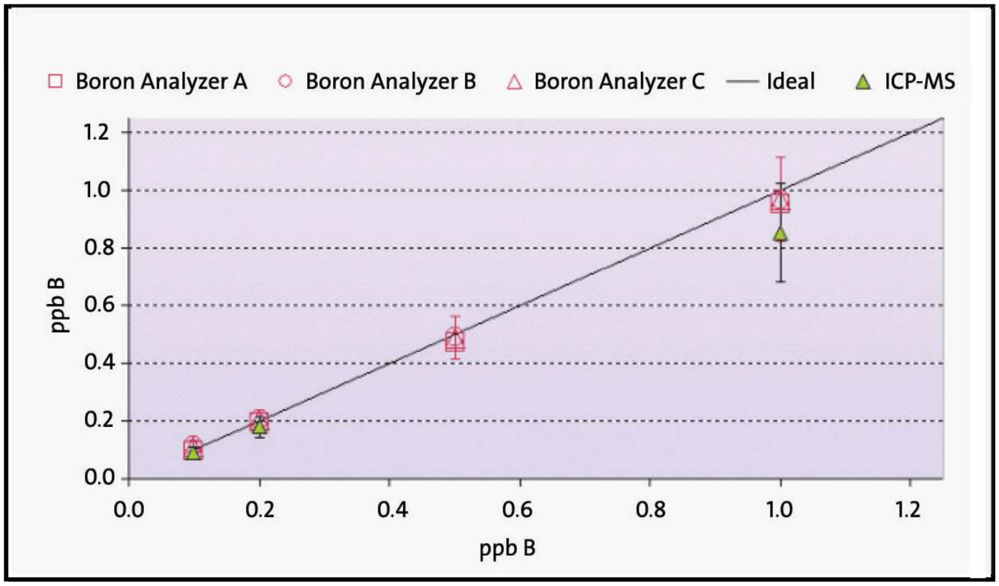

Figure 1. Comparison of low-level boron accuracy using the Sievers Boron Analyzer and ICP-MS

Process Optimization

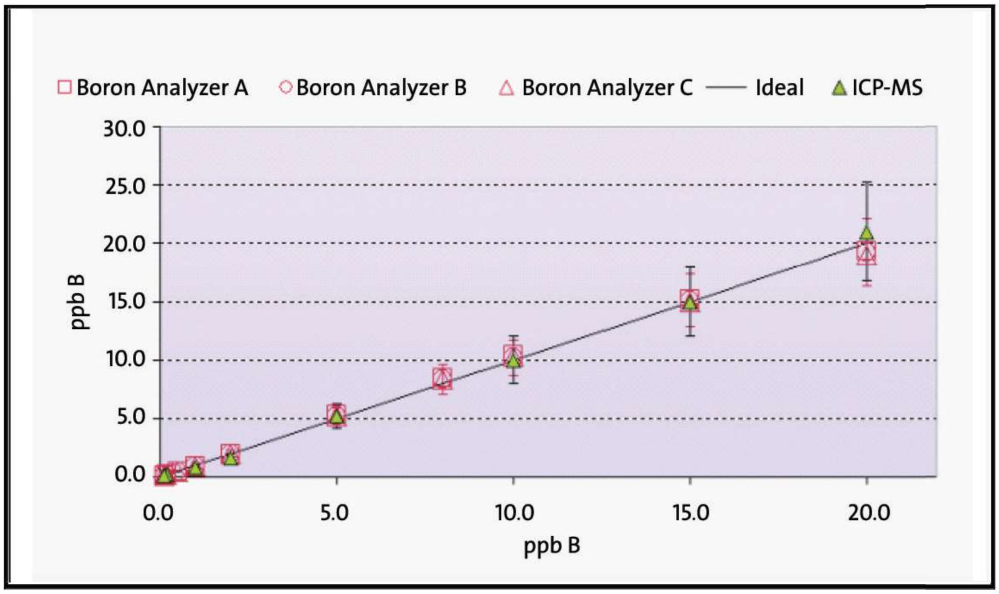

Figure 2. Comparison of high-level boron accuracy using the Sievers Boron Analyzer and ICP-MS

Due to boron's lower affinity to ion exchange resins than silica, boron breakthrough is typically underway for a prolonged time period before silica detection is possible with other online monitors. This exposes sensitive products and processes to both boron and silica before detection. The Sievers Boron Ultra Analyzer was created to predict mixed-bed exhaustion earlier, enabling better control of both silica and boron levels in final polish UPW systems.

Numerous published articles[1-5] identify boron as the best and earliest indication of mixed-bed ion exchange resin exhaustion, which can be leveraged for effective management of mixed-bed processes for optimized removal of both silica and boron. Consequently, Sievers Boron analyzers are now used in UPW systems globally to increase the lifetime of polish loop mixed-bed ion exchange resins, thereby reducing operational expenses[4].

Evolution

Driven by the contamination control needs for colloidal and reactive silica, and other ionic contamination, as well as the cost savings associated with prolonged resin life, boron control is a keystone of state-of-the-art water quality management programs worldwide. Monitoring for silica using ICP-MS or nonvolatile residual monitors (NRM) is a *reactive* approach. These total silica monitors will detect a signal increase only after silica and other ions have broken through the ion exchange resin bed and escaped downstream.

However, because boron breakthrough precedes the breakthrough of both types of silica, monitoring for boron provides *proactive* ion exchange process control. Figure 3 demonstrates the use of the Sievers Boron Analyzer as a tool to prevent the release of colloidal silica from a depleting mixed-bed ion exchange resin.[5,7]

Note the colloidal silica jump (detected by the NRM) shortly after boron began eluting from the bed as indicated by the Sievers boron instrument. At that point there was still no dissolved reactive silica detected by the online ionic chromatography (IC) silica analyzer. Because the Boron Analyzer detects an increase in boron, prior to the colloidal silica increase, it can be used to prevent the ion exchange leakage of colloidal silica, which also precedes dissolved silica breakthrough. The Sievers Boron Ultra Analyzer provides the means to significantly advance the quality and management of ionic silica, colloidal silica, and boron in ultrapure water.

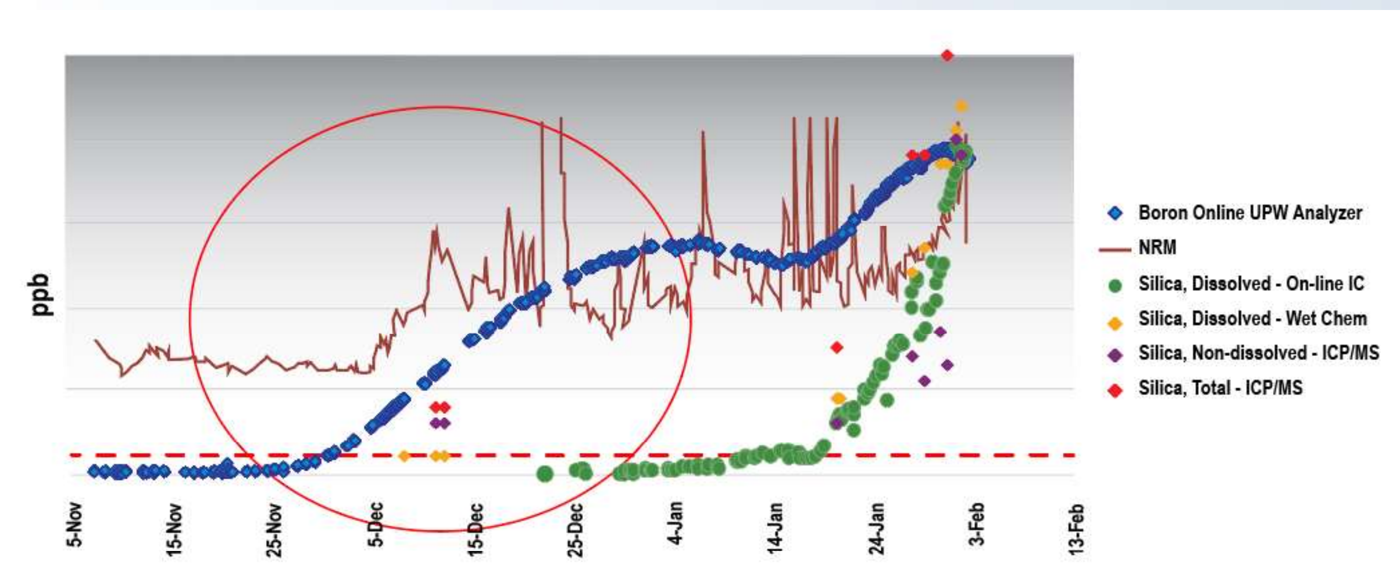

Figure 3: Mixed bed depletion data showing a colloidal silica breakthrough

SYSTEM SPECIFICATIONS

Applications

Semiconductor & Microelectronics Ultrapure Process Water

The Sievers Boron Ultra Online UPW Analyzer provides continuous, real-time boron concentration measurements down to the single parts-per-trillion. Boron is released from ion exchange resins prior to silica, colloidal silica, and other ionic contamination such as weak acids and bases. Measuring boron as a control variable provides proactive management of ionic contamination to prevent UPW excursions and increase yields. The Boron Ultra can be used to effectively determine the optimal timing for resin regeneration or replacement to reduce raw material waste, protect downstream processes, and reduce operational expense.

Common applications such as

Contamination Control | Compliance | Optimization of Resin Regeneration | Process Control

Features

Multi-Stream Options

Available in One-Stream, and Two-Stream which allows sequential sampling of up to two input streams

Enhanced Multi-Color GUI

Multi-color LED backlit, 10.1”, 1280 x 800 touchscreen display

Parts-Per-Trillion Sensitivity

Boron Ultra measurement range is 0.010 ppb B - 100 ppb B

Extensive Suite of Outputs

Boron Ultra outputs include: two isolated 4-20 mA Analog Outputs; two alarm outputs; two isolated Binary Outputs; two USB 2.0 Ports; and one Gigabit Ethernet Port

Boron Ultra meets all requirements for UKCA & CE marking

OPERATION SPECIFICATIONS

Range	0.010–100 ppb B
Limit of Quantification (LOQ)	0.030 ppb B
Limit of Detection (LOD)	0.010 ppb B
Accuracy	± 0.01 ppb B, < 0.03 ppb B ± 15 %, ≥ 0.03 ppb B
Precision	SD ≤ 0.003 ppb B, ≤ 0.100 ppb B RSD ≤ 3%, > 0.100 ppb B
Minimum Sample Resistivity	15 MΩ-cm
Sample Temperature	15-40 °C (59-104 °F)
Sample Flow Rate	50-400 mL/min
Sample Pressure	103-689 kPa (15-100 psig)
Calibration Stability	Typically 12 months
Sample Particulates	15-micron pre-filtration
Waste	Gravity drain (no back pressure), vented
Analysis Modes	Online, Averaged, and Online Timed
Analysis Time[1]	3 minutes or 6 minutes, User defined

ANALYZER SPECIFICATIONS

Power Requirements	100-240 VAC, 40 W[4], 50/60 Hz
Safety Cerftifications	CE, UKCA, ETL listed. Conforms to UL Std. 61010-1. Certified to CSA 22.2 No. 61010-1.
Display	LED Backlit, 10.1-inch, 1280 x 800 Display with touchscreen
IP Rating	IP 45
Inputs	3 isolated Binary inputs
Outputs	2 isolated 4-20 mA Analog Outputs[5]; 2 Alarm outputs; 2 isolated Binary Outputs; 2 USB 2.0 Ports[6] (one external, one internal); 1 Gigabit Ethernet Port;
Communication Protocols	Modbus TCP/IP
Transient Overvoltage	Installation (Overvoltage) Category II (Instrument Environment Pollution Degree 2 assumed for purposes of testing and judging insulation integrity)
Dimensions	54.2 H x 59.3 W x 38.8 D cm (21.35 H x 23.35 W x 15.27 D in)
Weight	Empty: 21.75 kg (48 lb); With Consumables: 23.1 kg (51 lb)
Minimum Clearances (for temperature, humidity control, and access)	Front: 48.3 cm (19 in); Rear 2.5 cm (1 in); Sides: 30.5 cm (12 in) each side; Top: 30.5 cm (12 in); Bottom: Analyzer stands provide desktop clearance.
Available Configurations	One-Stream or Two-Stream (Optional)
Ambient Temperature	10-40 °C (50-104 °F)
Altitude	Designed for use at altitudes up to 2000 m (6561 ft.)
Maximum Relative Humidity	Up to 95%, non-condensing

CONSUMABLES

Boron Reagent	45 days at 3-minute sampling rate[8] ; 90 days at 6-minute sampling rate[8]
Reagent Column	12 months
Zero Column	12 months
Peristaltic Pump Head	12 months

[1] *Service* Sample Flow Rate is > 200 mL/min. Required for onsite Calibration and Verification.
[2] *Service* Sample Pressure is > 138 kPa (20 psig). Required for onsite Calibration and Verification.
[3] Default time to first measurement is **~25** minutes; when using **Online** *Analysis Mode* set to use the default **3 minute** *Cycle Duration* and default **4.0 minute** *Flush Time*[7] setting.
[4] Rated to 70 W.
[5] The second 4-20 mA Analog Output is only available for the *Two-Stream* Analyzer configuration.
[6] The Analyzer only recognizes one USB memory device at one time. The internal USB Port should be used when the external USB Port is inaccessible.
[7] The *Flush Time* setting is dependent on the Analyzer environment and is based on the length of the Sample Line(s).
[8] When constantly running **Online** *Analysis Mode* 24-hours a day.

References

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3. Sushma Malhotra (AMD), Otto Chan (AMD), Theresa Chu (Balazs Analytical), and Agota Fusko (Balazs Analytical), "Correlation of Boron Breakthrough versus Resistivity and Dissolved Silica in a RO/DI System," Ultrapure Water, pp. 22-26, Vol. 13, No. 4, 1996.
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5 . Johnson, E. (Micron), Somerville, K. (Micron), Godec, R. (Sievers Instruments), Dunn, R. (Sievers Instruments), "The Analysis of Boron, Colloidal Silica, and Reactive Silica Leakage from Primary and Secondary Regenerable Mixed Ion Exchange Beds in an UPW System," Executive Forum Proceedings, Watertech 2002, Portland, OR.
6. Dunn, R., "New Analytical Technique Promotes Elimination of Silica in Feed, Steam and Condensate Systems," Presented at International Water Conference, Pittsburgh, PA, October 2002.
7. Godec, Richard, "Preventing the Release of Nano Materials from Depleting Ion-Exchange Beds by Using an Online Boron," Presented at ULTRAPURE WATER Conference, Portland, OR, November 2011, Tall Oaks Publishing, Inc.

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