Technology Readiness Level: **5**
Component and/or Breadboard Validation in Relevant Environment

Eltron Research & Development

Tech Brief

Real-Time TOC Analysis for Ultra-Pure Water

US Patent #
- 6,444,474

Slow total organic carbon (TOC) analysis can cause the loss of expensive materials in high-value industries and decreases the efficiency of both lab and production activities. Eltron Research & Development has developed TOC analysis technology for ultra-pure water that is at least 20 times faster than any TOC analyzer currently available.

Benefits and Applications

TOC analysis is a critical element of ultra-pure water systems. Eltron's TOC analyzer technology allows for samples to be analyzed, from start to finish, in less than 10 seconds. The actual oxidation of the sample only requires ~1 second. This makes it ideal for determining TOC levels in industries that rely on ultra-pure water, for example pharmaceuticals and semiconductors. In addition, Eltron's sensor technology has an accuracy comparable to the current industry standard. The benefits of Eltron's TOC sensor include:

- Cost savings resulting from avoiding contamination of expensive materials
- Faster production
- Easier trouble-shooting

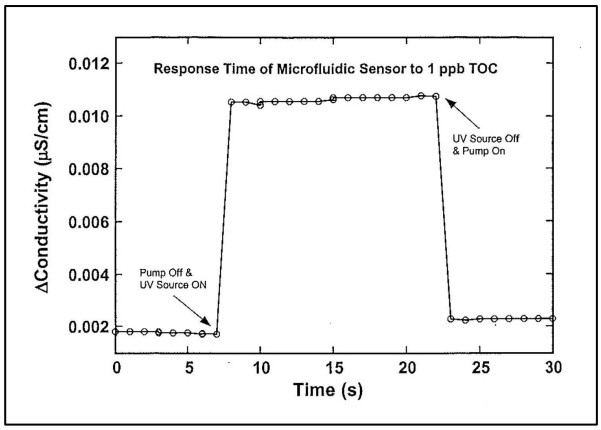

Figure 1. Response of microfluidic sensor during exposure to 2.7 ppb methanol, which is equivalent to 1 ppb TOC.

The Technology

Eltron's TOC analyzer uses photocatalysis to oxidize the organic carbon contaminants. Current is applied and measured to determine the amount of CO_2 (and thus original contaminants) that are present in the sample. TiO_2 is used as a catalyst to aid in the oxidation process. This is a simpler, more reliable option than using UV persulfate in ultra-pure applications.

The key to the impressive speed of the device lies in the ability to manipulate a very small sample volume, on the order of microliters per sample, and to simultaneously perform the conductivity measurement during the oxidation process. The oxidation and first measurement at complete oxidation take place in ~1 second, (see Figure 1). Furthermore, since the volumes being pumped in and out of the analysis chamber are small, the overall measurement time is further reduced from standard TOC measurement techniques.

Stage of Development

Eltron has invested approximately three years and $1 MM developing our ultrafast total organic carbon (TOC) measurement device for ultrapure water (UPW) applications. This effort resulted in a patented technology which encompasses the design and use of a microfluidic device for doing quantitative catalytic photooxidative TOC measurement in a matter of seconds rather than the minutes. Eltron also has been granted broad coverage for using micro-fluidic samples in TOC analysis, US patent 6,444,474 *Microfluidic System for Measurement of Total Organic Carbon.*

Prototype TOC analyzer with probe assembly.

By the conclusion of the R&D effort, we had demonstrated complete photooxidation of 1 ppb TOC in about 1 sec. using the patented device design and standard TOC compounds (methanol). TOC concentrations between 0.6 and 80 ppb (as methanol) were tested. The detection limit was below 1 ppb TOC. We also validated the Eltron TOC technology's conductivity cell versus commercial conductivity instrumentation using standard additions of bicarbonate to the system. Long term stability of the TOC device during continuous online UPW monitoring was also validated versus a commercial conductivity device, over a 2 ½ month period. The Eltron device correlated very well with the commercial conductivity cell in this long-term test.

We have demonstrated that the microfluidic device can measure TOC in UPW at ppb levels with sub-pbb detection limits. Exhaustive oxidation takes about 1 sec. at ppb TOC levels. The next steps in development will involve fabricating and testing a higher quality prototype device, one that will be closer in design and built with materials that would be expected to be used in a production environment. Further validation must also be performed with TOC compounds representing the full range of oxidizability and chemical forms encountered in UPW production environments.

The technologies described, and all related inventions are owned by Eltron Research & Development Inc, and protected by copyrights, trademarks, issued and pending patents, trade secrets, or other applicable intellectual property rights.

Contact Us

To discuss the possibility of entering into a business relationship with Eltron, contact the Business Development Group at business@eltronresearch.com.

To learn more about Eltron Research & Development and the many technologies that the company is researching and commercializing, visit www.eltronresearch.com.

Eltron Research & Development

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