



## Microelectrode Arrays for the Analysis of Dissolved Oxidants in Water

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Dissolved oxidants are either naturally present in water or are intentionally added for disinfection, bio-fouling control, bleaching and other applications. Continuous on-line monitoring of oxidant concentration is necessary in various fields such as drinking water quality control, waste water treatment, industrial process water monitoring. On-line sensors should be cost effective, maintenance-free and reliable. They should be able to tolerate prolonged exposure to an aqueous environment along with variations in conductivity, pressure, flow rate, pH and temperature as well as interference due to other chemicals or microbiological species. Microelectrode based sensors provide unique solutions to some of these issues, in particular because their response is almost independent of the convective regime and of the water conductivity.

CSEM has developed an electrochemical platform based on microfabricated microelectrode arrays and a dedicated versatile miniaturized potentiostat for many years. The three-electrode amperometric sensor used for oxidant analysis comprises a gold microdisc array working electrode, a silver/silver chloride reference electrode and a stainless steel counter electrode. Arrays of microdisc electrodes are integrated on silicon wafers using a sequence of thin film deposition and etching steps based on microelectronic fabrication technologies. Gold has been chosen as an electrode material for dissolved oxidants mainly because of its overall good response and appropriate *in situ* activation characteristics. The Figure 1 shows a view of a mounted sensor. This packaging has been tested for water pressures up to 20 bar.

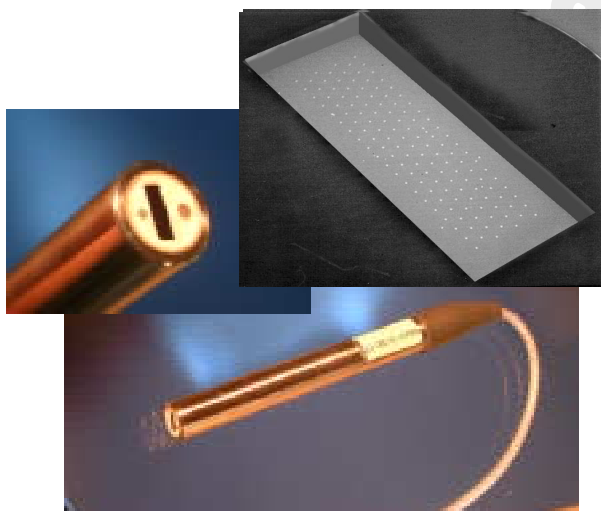


Figure 1  
Sensor package: 2.8 x 7 mm silicon chip and front view with reference and counter electrodes

Recent work has been mainly focused on free chlorine monitoring.

Results have demonstrated good sensor linearity in a wide concentration range (0-20 mg/l), a low detection limit (0.02 mg/l) and a good stability under continuous use in field tests.

This later characteristic is achieved by applying a specific *in situ* electrochemical cleaning step before each measurement. Figure 2 shows the sensor response to free chlorine concentration in Neuchâtel tap water. An excellent correlation with the reference DPD photometric method has been observed over the full test period.

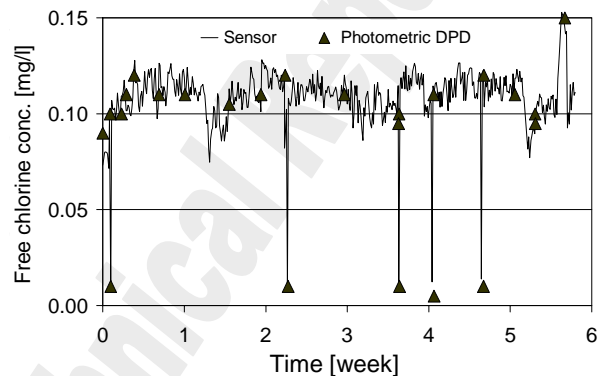


Figure 2  
Free chlorine in Neuchâtel drinking water: line microdisc array sensor, squares DPD photometric reference method; low values: after bypass on activated carbon filter to remove free chlorine

The analysis of a number of other important oxidizing agents, including ozone, hydrogen peroxide, peracetic acid, has been evaluated, as well as the monitoring of dissolved oxygen in water. Promising results, in terms of linearity and detection limits, have been obtained by using appropriate working electrode polarization potentials. Figure 3 shows in particular the good linearity and the low detection limit, < 5 ppb, obtained for dissolved ozone in water.

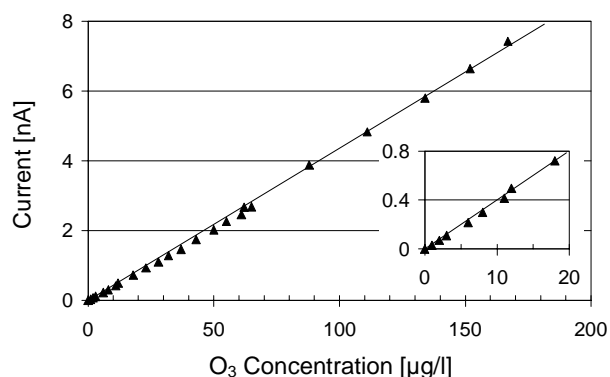


Figure 3  
Microdisc array response to dissolved ozone in water

Future developments will aim at further characterizing the sensor performances under real application conditions. Multiple analyte detection will also be evaluated.