GSS (Gas Sensitive Semi-Conductor) Technology Introduction

AIR MONITORING

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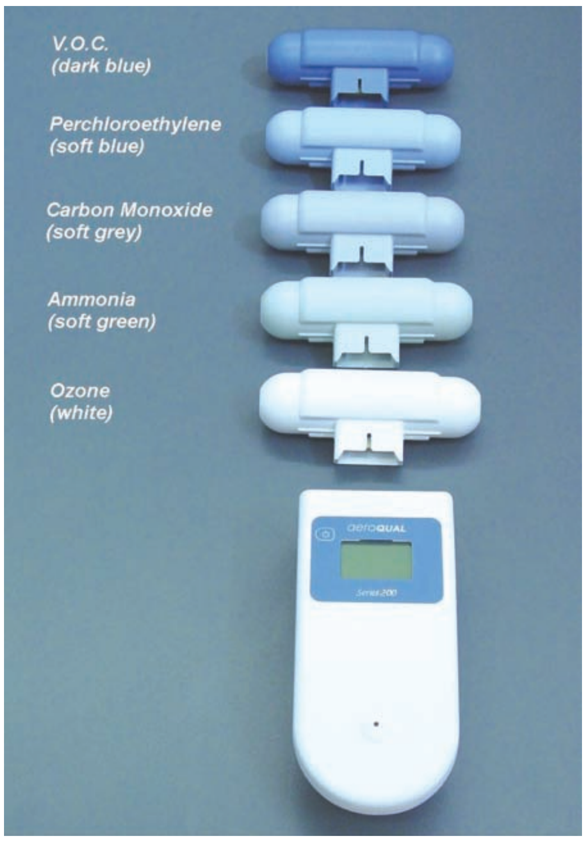
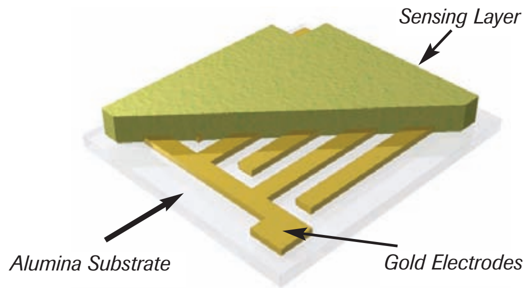
Gas Sensitive Semiconductor (GSS) technology is a combination of smart measurement techniques and mixed metal oxide semiconductor sensors that exhibit an electrical resistance change in the presence of a target gas.

This resistance change is caused by a loss or a gain of surface electrons as a result of adsorbed oxygen reacting with the target gas. If the oxide is an n-type, there is either a donation (reducing gas) or subtraction (oxidising gas) of electrons from the conduction band. The result is that n-type oxides increase their resistance when oxidising gases such as NO_2 and O_3 are present while reducing gases such as CO and hydrocarbons lead to a reduction in resistance. The converse is true for p-type oxides where electron exchange due to gas interaction leads either to a rise (oxidising gas) or a reduction (reducing gas) in electron holes in the valence band. This then translates into corresponding changes in electrical resistance. Quantitative response from the sensor is possible as the magnitude of change in electrical resistance is a direct measure of the concentration of the target gas present.

Since it is the surface reaction that causes the change in electrical resistance in the sensing oxide, it is beneficial to maximise the surface area to intensify the response to gas. To take advantage of this effect, commercial gas sensors consist of highly porous oxide layers, which are either printed or deposited onto alumina chips. The electrodes are usually co-planar and located at the oxide/chip interface (see diagram). A heater track is also applied to the chip to ensure the sensor runs "hot" which minimises interference from humidity and increases the speed of response. The microstructure of the oxide, its thickness and its running temperature are optimised to improve selectivity. Catalytic additives, protective coatings and activated-carbon filters are also applied to enhance selectivity.





Typical Sensor Formulation

Aeroqual has applied more than 25 years of materials research perfecting material formulations and optimizing sensor driver algorithms. Through the use of proprietary microprocessor driven code, reliable surface mount production, rigorous calibration procedures and exhaustive testing, Aeroqual has dramatically improved accuracy, T90 response, cross-sensitivities and sensor drift over competing technologies. An innovation welcomed by the market is the concept of fully interchangeable sensor heads which eliminates the need for field calibration and provides users with unique application focused solutions. The company maintains a strong research and development team and a commitment to market focused product development.

A comparison of an Aeroqual Series 500 monitor (with O_3 sensor head) against a Thermo Electron TEI 49C photometer (utilising UV absorbance technology) demonstrates the high accuracy and reliability of GSS technology. This work was recently undertaken by the Chemistry Department of the University of Cambridge in the United Kingdom in association with Cambridge Atmospheric Measurements Limited. While Aeroqual does not claim the same accuracy for its products as scientific instruments using optical analysis (typically ± 1 ppb), the Series 500 monitor showed similar trends and gave readings within the specified accuracy level (± 8 ppb from 0 to 0.1 ppm and ± 10% from 0.1 to 0.5 ppm).

The Aeroqual range of products features portable and fixed instruments utilising the aforementioned GSS technology providing for the first time superior specificity, lower detection limits and cost effectiveness in gas monitoring and detection. A variety of different gases are offered such as O3, SO_2, CO, NO_2, NH_3, H_2S, H_2O_2, VOC's (both specific and total) and many more are in development. The products are distributed in the UK by Air Monitors Limited.

Independent Test Report

This work was undertaken in the Chemistry Department of the University of Cambridge (UK) in association with Cambridge Atmospheric Measurements Limited.

A Nalgene box (30•30•17.5 cm, ~1 cm wall thickness, volume ~12 litres) was used to investigate the Aeroqual S500 (A500) at ozone mixing ratios above ambient levels. The A500 was enclosed in the box with its inlet sampling the same volume as the Thermo Electron TEI49C photometer, via 1 metre of 0.25" Teflon lined Tygon tube. Ozone was generated by the DEC5008 ozone generator and added to the box in a 5slm flow of 4:1 N_2:O_2. This flow was mixed with a humidified (~85% RH.) 2 slm flow of N_2, leading to a relative humidity of ~20% and an oxygen mixing ratio of 0.14 within the box. A relative humidity of > 5% is necessary for the A500 to function. Reducing the relative humidity in the box to 10% did not affect the A500 readings.

The response of the sensors to a range of ozone mixing ratios is shown below.

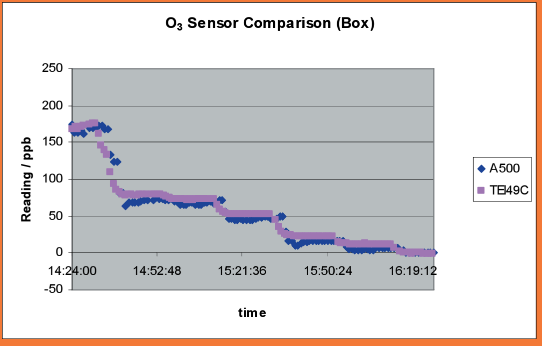


Figure A – Both sensors plotted against time

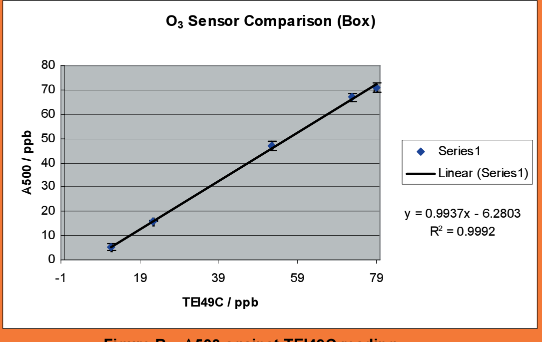


Figure B – A500 against TEI49C reading