

Mixed Potential Sensors for CO Monitoring

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Carbon monoxide (CO) is a toxic gas that results from the incomplete combustion of fossil fuels and can be emitted from any fossil fuel burning appliance. Thousands of CO poisoning cases are reported in the US each year, resulting in at least 250 deaths [1]. Therefore, CO detectors for indoor air quality monitoring are becoming increasingly popular. The most commonly used technologies to sense CO are: a) biomimetic sensors, b) metal oxide semiconductor (MOS) sensors and c) electrochemical sensors. While biomimetic sensors are the cheapest they are plagued by low sensitivity, low selectivity, short lifetimes, and interference from particulate matter. The MOS sensors are more reliable but are still not accurate at the low (<60) ppm levels and their response is influenced by changing humidity content and the presence of other interference gases.

Electrochemical sensors are to date the most reliable sensors for the detection of CO. The current designs use a fuel-cell type electrochemical sensor that detects the presence of CO by oxidizing it on a sensing electrode. A potential sufficient to oxidize CO is applied between a reference electrode and the sensing electrode and current is measured as a function of time. This current is linearly proportional to the concentration of CO present in the gas [2]. These sensors typically operate at room temperature and use an acid electrolyte. Although these electrochemical sensors overcome several disadvantages of the MOS sensors, they are susceptible to leakage of the liquid electrolyte and poisoning of the sensing electrode. In this paper we discuss the possibility of using a solid-state high temperature ($\approx 400^\circ\text{C}$) electrochemical sensor for CO monitoring in air. These sensors combine the advantages of a solid-state device like the MOS sensor with the advantages of an electrochemical sensing mechanism. Moreover these sensors are potentiometric devices which greatly simplifies the electronics required.

When an oxygen-ion conducting electrolyte is exposed to a reducing gas (CO, H₂, NO or unsaturated hydrocarbons) at $T \leq 800^\circ\text{C}$, a non-nernstian potential develops at the electrode [3,4]. This mixed-potential has been studied for various metal (Au, Ag, Pt) electrodes on zirconia-based electrolytes [5,6]. We also recently reported that the zirconia-based sensors were not as stable as those based on a ceria-electrolyte and discussed how the oxygen reduction kinetics at the electrode/electrolyte interface is critical in determining the sensor response [7].

In this paper we report the response ($T \approx 400^\circ\text{C}$) of "Pt/Ce_{0.8}Gd_{0.2}O_{1.9}/Au" sensors to the presence of CO in room air. The response of these sensors is compared to those of "Pt/Zr_{1-x}Y_xO_{2-x/2}/Au" and "Pt/Bi_{0.8}Er_{0.2}O_{1.5}/Au" sensors and the effect of varying the electrolyte composition on the sensor response is analyzed. The response of these sensors (Fig. 1) is discussed in light of the mixed potential theory [7]. The "Pt/Ce_{0.8}Gd_{0.2}O_{1.9}/Au" sensor with an activated carbon filter has been found to meet the sensitivity, response

time, interference and stability standards stated in the UL 2034 (1995) standards for CO monitors.

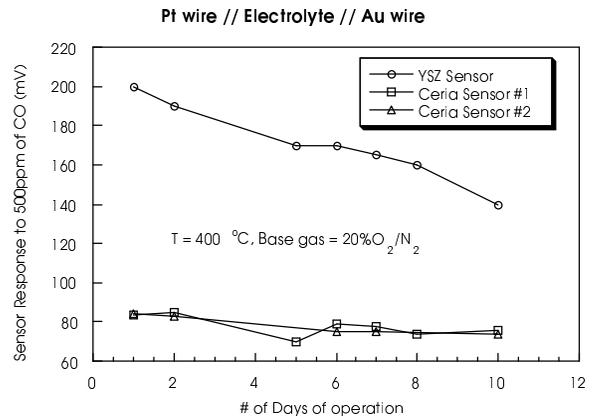


Fig. 1. Response of Zirconia and Ceria based sensors to 500ppm of CO

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