

Mixed Potential Hydrocarbon Sensors Based On A Yttria Stabilized Zirconia Electrolyte and Ceramic Electrodes

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When an yttria stabilized zirconia (YSZ) electrolyte-based sensor is exposed to a gas mixture containing oxygen and reducible or oxidizable gases such as CO, unsaturated hydrocarbons, or NO_x, a non-nernstian potential may develop at the electrode (1,2). This non-equilibrium potential is controlled by the heterogeneous catalysis that occurs on the sensor surfaces and the kinetics of the various electrochemical oxidation and reduction reactions, and is known as the mixed-potential. The mixed potential response of various metal and metal-oxide electrodes have been studied in the past and several sensor designs have been proposed to sense CO (3,4), HCs (5,6), and NO_x (7,8).

The major impediment towards the commercialization of the mixed-potential sensors has been their long-term stability, sensor-sensor reproducibility and selectivity. In order to address these critical issues, the various kinetic factors that affect the mixed-potential at an electrode/electrolyte interface have been examined (9). It has been determined that the oxygen reduction kinetics at the electrode/electrolyte interface, and the amount of heterogeneous catalysis of the gas species before reaching the electrode/electrolyte interface, have a marked influence on the sensor response. These factors have been incorporated into kinetic models (10) and a new generation of sensors have been developed that yield stable and reproducible response over time (11).

In this paper we report the response of "Pt/Zr_{0.85}Y_{0.15}O_{1.925}/La_{0.8}Sr_{0.2}Cr_{0.2}MnO₃" sensors to HCs in the presence of 1% O₂. Figure 1 illustrates the effect of varying the ceramic-electrode composition on the sensor response. While the sensor with the La_{0.8}Sr_{0.2}CrO₃ electrode has a response of 75mV to 500ppm of propylene, the sensor with the La_{0.8}Sr_{0.2}MnO₃ electrode shows negligible response when the propylene concentration is < 1000ppm. This effect is attributed to the catalytic properties of the ceramic and the effect it has on the oxidation and reduction reactions at the electrode/electrolyte interface. A more catalytic electrode material results in greater heterogeneous catalysis and lower oxygen reduction potentials thus leading to a lower mixed-potential response.

The effect of varying the electrolyte composition on the sensor response is illustrated in Figure 2. The electrolyte with the higher conductivity results in a lower mixed-potential response. This can be attributed to the fact that the oxygen reduction kinetics at an electrode/electrolyte interface is improved by an increase in the conductivity of the electrolyte. In conclusion, the sensor response can be optimized by varying the electrode and/or electrolyte composition and morphology.

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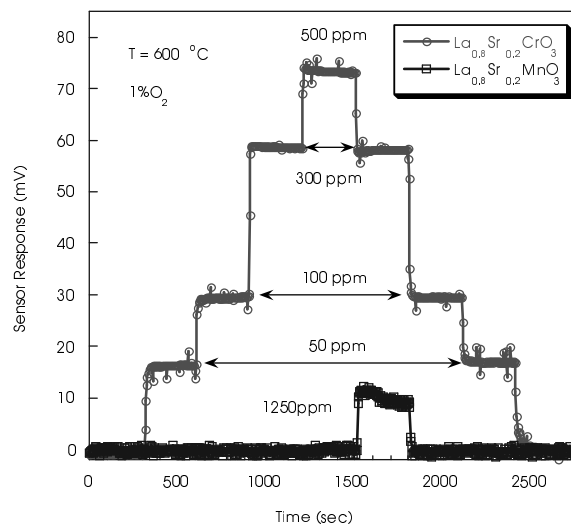


Figure 1. Propylene response of 2 sensors with different electrode compositions

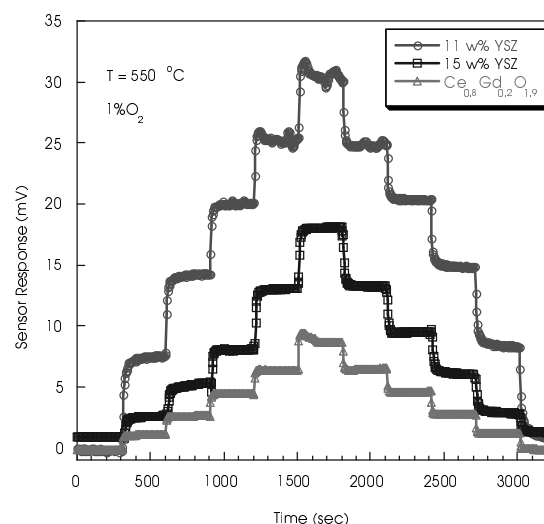


Figure 2. Propylene response of 3 sensors with different electrolyte composition

