

**Third Winner**

**Invention**

**Project Title**

**Design and Fabrication of a Novel and Miniaturized Solid-State Reference Oxygen Sensor for Automotive and other Applications**



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**Abstract**

Potentiometric oxygen sensors based on yttria-stabilized-zirconia (YSZ) solid electrolytes are widely used in exhaust gas emission control systems of spark ignition engines. About 120 million of oxygen sensors are used in the World annually. Through ECU, the sensor controls the air-to-fuel ratio of the engines in a stoichiometric region. The use of oxygen sensor not only reduces the fuel consumption, but also, in combination with a catalytic converter, significantly diminishes the emission of HC, CO, and NO<sub>x</sub>.

The conventional oxygen sensors use the YSZ solid electrolyte, each side of which is coated with a porous platinum electrode. One of the electrodes is exposed to the exhaust gas and the other, through a massive sealing, is connected to air as a reference oxygen concentration. At about 500 °C, the sensor shows a low-high transition in voltage as the air-to-fuel ratio changes from a fuel-lean to a fuel-rich.

The novel sensor fabricated in this project uses a metal oxide semiconductor, such as ceria, titania, ..., mixed with YSZ as a solid reference that eliminates the need for the air reference and accompanying massive sealings. The solid reference film is deposited on one of the porous electrodes and the whole sensor is immersed in the exhaust gas. The sensor shows the transition negative to positive voltages close to the stoichiometric region at about 400 °C. This way the sensor can be miniaturized. The novel sensor has short response time, particularly in cold start, lower operating temperature, and lowers price.