

SolidSense: A Gas Analyzer on a Chip

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Technology description

The only sensor platform that measures all EPA regulated gas emissions (nitrogen oxides, carbon monoxide, and hydrocarbons) in addition to ammonia with high accuracy and sensitivity. Designed to operate in hostile high temperature combustion environments, SolidSense operates without the need for cooling or filtration. The ceramic-based mixed-potential sensor comprises three electrodes connected to an artificial neural network. The differences between the catalytic activities of the electrodes for the electrochemical oxidation/reduction of the target gases provides the signals for concentration determination. The artificial neural network provides signal processing to determine compound concentration from sensor electrode output voltages. The device enables real-time diagnostics with response times less than 1/100 of a second.

Background

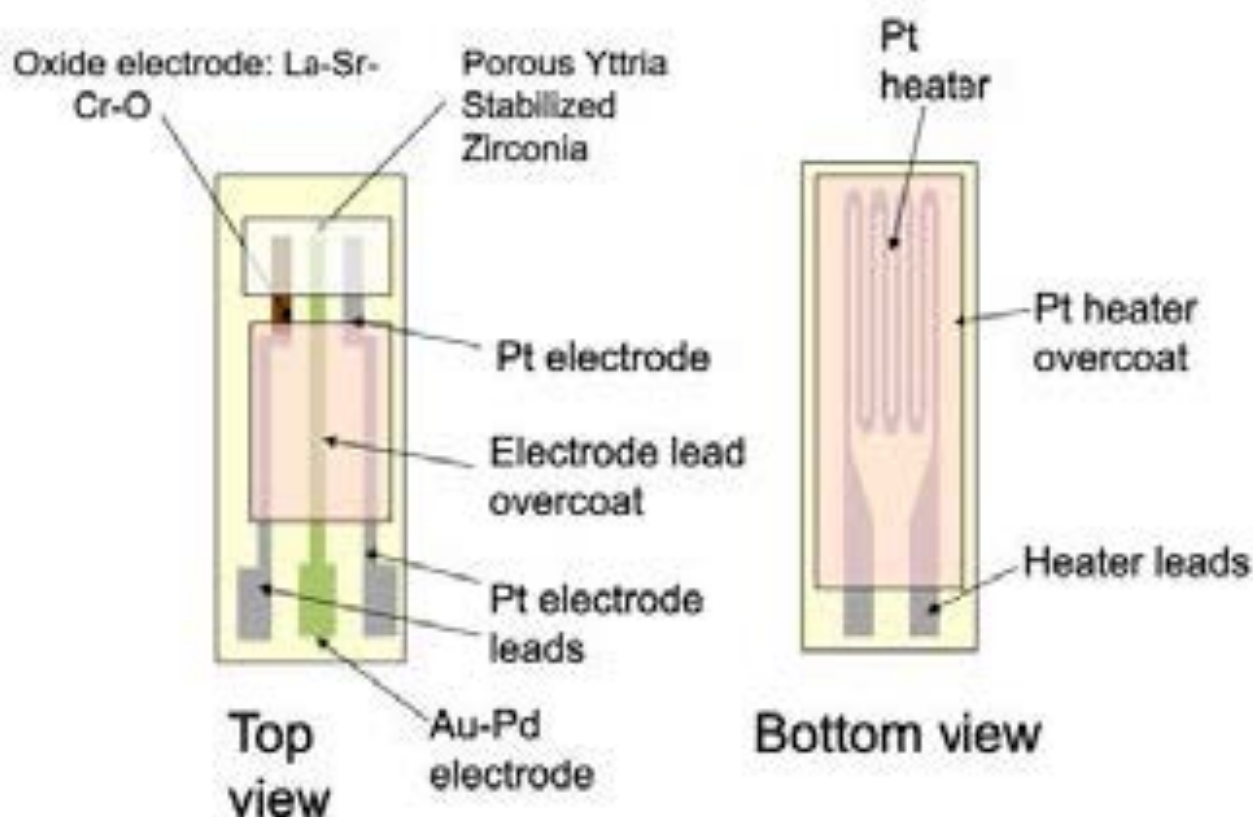
Lean burn gasoline and diesel engines use a high air-to-fuel ratio. This ensures high fuel combustion efficiency and to lower CO and hydrocarbon (HC) emissions. However, the resulting excess oxygen partially reacts with nitrogen to create nitric oxides, requiring lean burn diesel engines to have a two-stage catalytic system to eliminate pollutants. There are currently no sensors installed in automobiles that can quantitatively monitor the concentration of pollutants in the exhaust gas stream. Mixed-potential electrochemical sensors are a promising technology for on-board emissions monitoring in vehicles, but such sensors need to be robust in the atmosphere of exhaust gas, have low cost, and be able to distinguish between the different pollutant gases which may be present.

Technology Description

Researchers from the University of New Mexico and Sandia National Laboratories have developed the only sensor platform that measures all EPA regulated gas emissions (nitrogen oxides, carbon monoxide, and hydrocarbons) in addition to ammonia with high accuracy and sensitivity. The SolidSense chip-scale gas analyzer provides real-time diagnostics and is suitable for monitoring emissions from diesel and gasoline engines, turbines, steam power plants, and other combustion technologies. This novel device replaces a complex and expensive rack of chemical analysis equipment currently used today. Designed to operate in hostile high temperature combustion environments, SolidSense operates without the need for cooling or filtration. The ceramic-based mixed-potential sensor comprises three

electrodes connected to an artificial neural network. The differences between the catalytic activities of the electrodes for the electrochemical oxidation/reduction of the target gases provides the signals for concentration determination. The artificial neural network provides signal processing to determine compound concentration from sensor electrode output voltages. The device enables real-time diagnostics with response times less than 1/100 of a second.

The sensor's ceramic platform enables easy manufacturing through thick film, high temperature co-fired ceramic technology. It also has potential applications in explosive detection and can be integrated into a hand-held device to provide a molecular fingerprint of explosive compounds.



Video

[R&D 100 Winner 2017: SolidSense - A "Gas Analyzer on a Chip"](#)

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SUPPORTING TECHNOLOGY TRANSFER AND CATALYZING ECONOMIC DEVELOPMENT AT THE UNIVERSITY OF NEW MEXICO

Application area

This all-in-one method on a chip the size of a penny uses differences between the catalytic activities on the electrodes and an artificial neural network to output compound concentration from voltage

The platform responds in less than 1/100 of a second at 95% accuracy when discriminating individual components at PPM levels

Low cost, mass production prototypes successfully demonstrated

Allows for improved combustion efficiency, detection, and molecular fingerprinting of explosive control diagnostics

Suitable for control and monitoring of diesel and gasoline engines, turbines, steam power plants, and other combustion markets

SolidSense provides valuable exhaust chemistry feedback that can assist in improving combustion efficiency for engines, turbines, and power plants

Provides quantitative data to monitor and control the emissions of hydrocarbon, carbon monoxide, nitrogen oxides and ammonia

No cross interference from CO_2 or H_2O

Real-time diagnostics—no sampling lag time

Direct operation in exhaust gas streams

Does not need frequent recalibration

Large throughput manufacturing using high temperature co-fired ceramics

Institution

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