Heavy Vehicle Propulsion Materials

Development of an NO_x Sensor for Heavy Vehicles

Background

Under the direction of the U.S. Department of Energy's Office of Transportation Technologies, Oak Ridge National Laboratory (ORNL) is conducting research and development on the reduction of emissions in transportation.

Sensors that can measure NO, NO_2, or total NO_x emissions in real time are an enabling technology for the clean diesel engines of the future. Closed-loop engine control systems that monitor emissions and continuously adjust engine and emission-control parameters such as fuel injection behavior, valve timing, exhaust gas recirculation, and air-handling control are envisioned for near-zero emission heavy vehicles for the future. However, closed-loop control systems are dependent upon rapid, reliable, and accurate sensors. The current class of commercial electrochemical sensors are prohibitively expensive to implement due to the need for costly electronics to enhance the exceptionally small output signals.

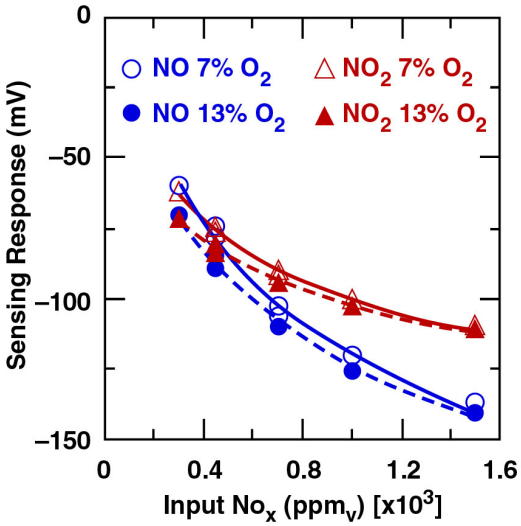
The Technology

ORNL and Ford Motor Company have entered into a cooperative research and development agreement (CRADA) to develop an NO_x sensor for heavy vehicle applications. The objective of the project is to develop a simple, low-cost electro-chemical sensor that measures the concentration of NO or total NO_x (NO + NO_2), between 600 and 700°C with a response time of one second or less.

Key challenges being addressed by this project are the development of catalytically active electrode materials, the use of an applied bias to stimulated catalysis, and validation testing.

ORNL is developing a mixed potential sensor that can be heated within 1 to 2 seconds to the operating temperature (600 to 700°C). As part of this project, ORNL is investigating and screening catalysts that facilitate the decomposition of NO and NO_2 at high temperature and investigating the effects that oxygen and humidity have on sensor output and longevity.

Less dependence on foreign oil, and eventual transition to an emissions-free, petroleum-free vehicle



Sensor response to NOx showing tolerance to changes in oxygen content.

Benchmark experiments have resulted in materials and design improvements, leading to a working bench-scale total NO_x sensor capable of NO_x detection from 1 to >1500 ppm. Current sensors are tolerant of oxygen fluctuations in the exhaust stream, eliminating the need for additional oxygen sensors to control drift.

In a parallel effort, Ford is prototyping small numbers of sensors to validate ORNL's bench-scale results and to further test the materials and designs on simulated exhaust gas.

Commercialization

This effort is ongoing, and several technical barriers remain to be overcome before the sensors will be commercialized. Ford is currently testing prototypical sensors in a simulated exhaust environment. The CRADA with Ford Motor Company provides a clear path to commercialization.

Benefits

- New materials and designs have generated output signals three times greater than previously observed.
- New designs and materials result in O_2-tolerant NO_x sensors, eliminating the need for additional O_2 sensors in the exhaust stream.
- NO_x sensors can be used for closed-loop control of emission control technologies and optimum engine operation

Where Can I Find More Information?

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