PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

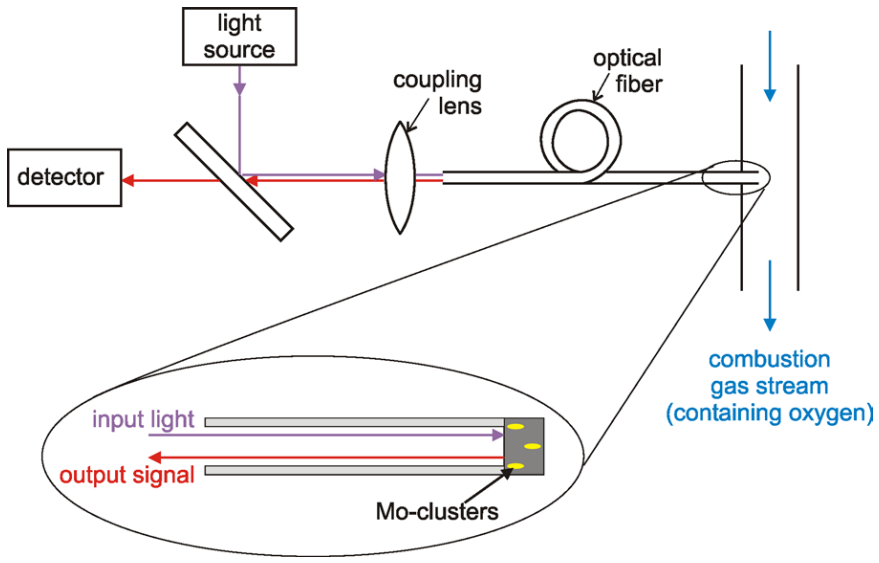
Advanced Research

09/2004

FIBER OPTICAL MICRO-DETECTORS FOR OXYGEN SENSING IN POWER PLANTS

Description

Efficient use of fossil and renewable fuels in combustion and gasification requires sensors to monitor the levels of gaseous oxygen at high temperature. In combustion processes, real-time monitoring of oxygen levels increases efficiency by maximizing the heat that is extracted from the fuel and minimizing the emission of unwanted byproducts (pollutants). At high temperatures, current oxygen sensors either fail or operate poorly. Michigan State University has recently developed a simple optical fiber sensor for measuring oxygen at room temperature and is working to adapt it for high temperature environments. It has a fast response (< 1second) and can detect oxygen over a broad concentration range (0.1 - 20%). The sensing element in the device is a molybdenum (Mo) metal cluster whose luminescence or brightness depends on the local oxygen concentration.



Schematic of the fiber optic oxygen sensor. An ultraviolet light source excites the molybdenum clusters at the far end of the fiber. The resultant red luminescence, which depends on the local oxygen concentration, is collected by the detector.

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PROJECT COST

Total	$600,000
DOE	$477,545
MSU	$122,455

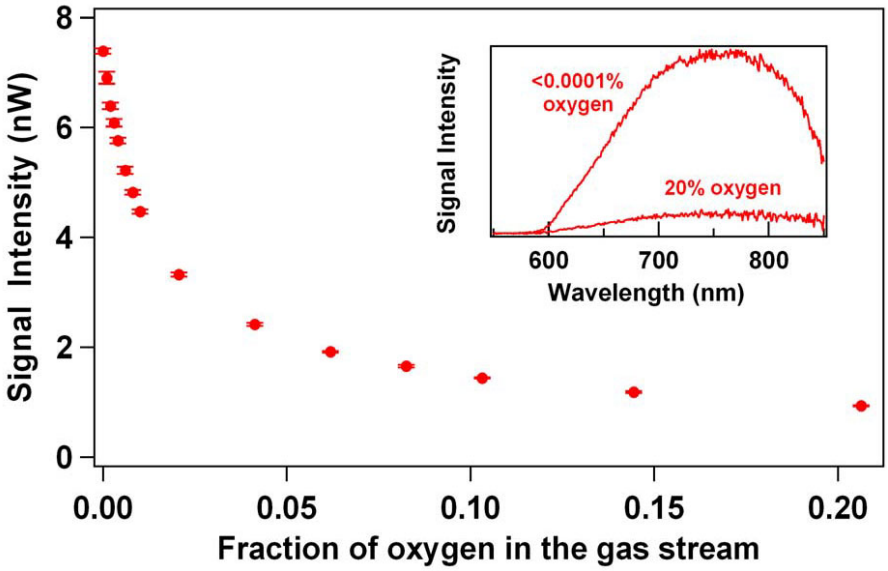
PROJECT DURATION

10/01/2002 – 10/31/2005

WEBSITES

www.netl.doe.gov/coal

The goal of this project is to alter the design of the room temperature sensor so it can be used at high temperatures, possibly up to 600 °C. Results to date include the incorporation of the Mo-clusters in an inorganic matrix that is stable at elevated temperatures. The individual components of the sensor have been cycled from room temperature to 200 °C. No change in sensor response or properties were observed, indicating the stability of the material to 200 °C.



Sensor signal as a function of the fraction of oxygen in the gas stream. The inset shows how the red emission from the clusters is quenched by oxygen.

Further reading: "Fiber-optic oxygen sensor using molybdenum chloride cluster luminescence", R. N. Ghosh, G. L. Baker, C. Ruud and D. G. Nocera, Appl. Phys. Lett. 75, p. 2885 - 2887 (1999).