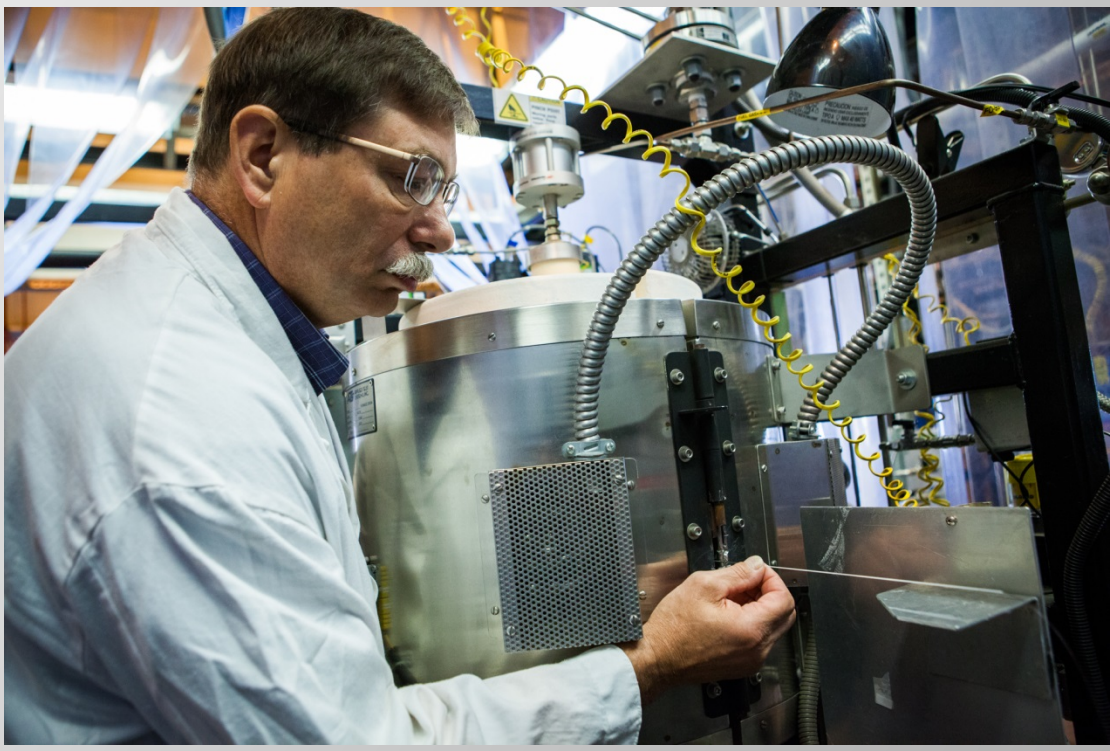
Embedded Optical Sensors for Extreme Temperatures and Harsh Environments



For more information, contact
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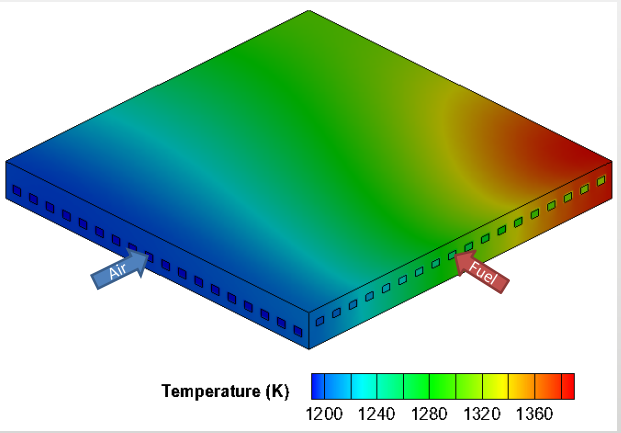
The Need

- **Harsh environment sensing in energy applications such as gas composition in gasification, natural gas processing, fuel cells, gas turbines, and other energy conversion systems can help improve efficiency and reduce emissions.**

The Problem

- These systems are becoming increasingly complex and are subject to harsher environments (higher temperatures and pressures) as energy efficiency is improved and emissions and safety regulations are implemented.
- However, there are no commercial solutions available for embedded sensors capable of both chemical and temperature sensing above 500°C.

	Coal Gasifiers	Combustion Turbines	Solid Oxide Fuel Cells	Advanced Boiler Systems
Temperatures	Up to 1600°C	Up to 1300°C	Up to 900°C	Up to 1000°C
Pressures	Up to 1000psi	Pressure Ratios 30:1	Atmospheric	Atmospheric
Atmosphere(s)	Highly Reducing, Erosive, Corrosive	Oxidizing	Oxidizing and Reducing	Oxidizing
Examples of Important Gas Species	H_2, O_2, CO, CO_2, H_2O, H_2S, CH_4	O_2, Gaseous Fuels (Natural Gas to High Hydrogen), CO, CO_2, NO_x, SO_x	Hydrogen from Gaseous Fuels and Oxygen from Air	Steam, CO, CO_2, NO_x, SO_x



Solid Oxide Fuel Cell internal gas and temperature distribution

The Competition

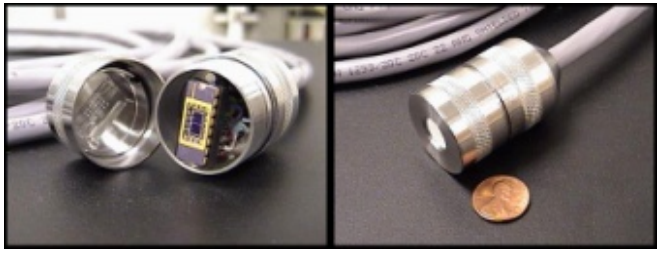
Traditional Electrical Sensors:

- **prohibitively costly and intrusive**
- **require stable wiring, insulation, electronic components**

Complex Optical Sensors

- **expensive**
- **inherent temperature instability issues**

Thermocouples



Chemi-resistive Sensors

OMEGA's F2020, 100 Ω, Class "A" thin-film element, see page C

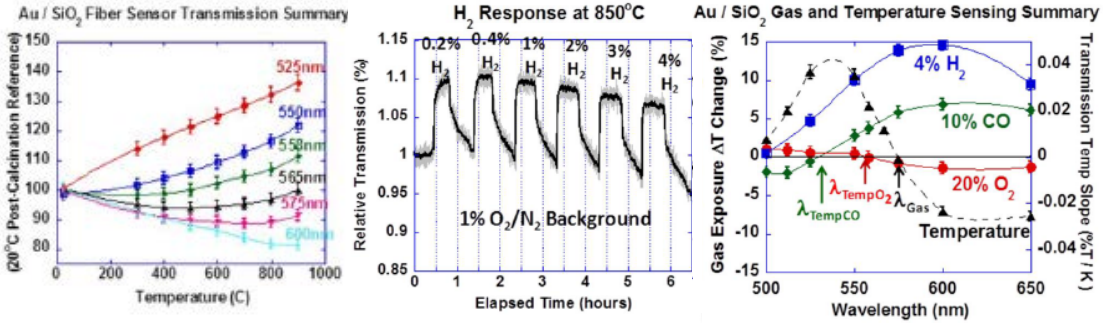
RTDs

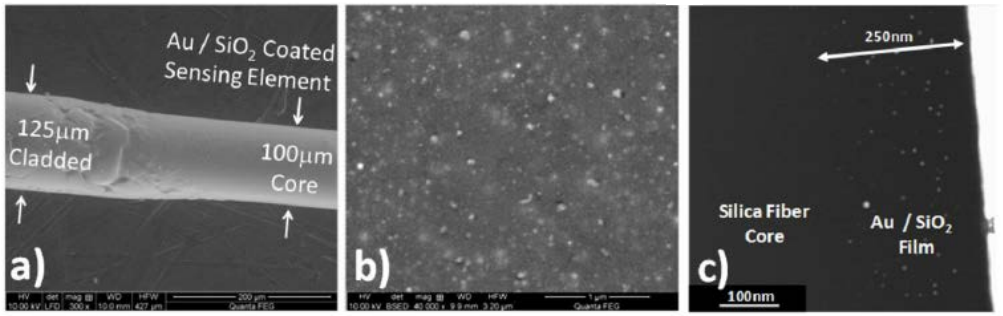
Commercially Available Sensors

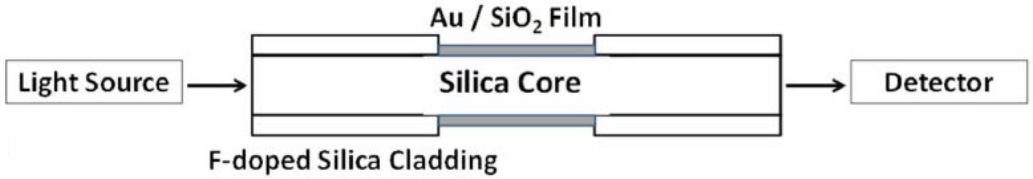
The Technology Solution

Optical sensors enabled by advanced sensing materials for the embedded sensing of temperature and gas composition in extreme, high temperature environments:

- **Potentially capable of operation in temperatures approaching 900°C**
- **Minimize or eliminate wires and electrical contacts at the sensing location**
- **Stable, reliable, safe, and cost-effective**
- **Multi-function capability (gas and temperature)**
- **No comparable commercial sensor on the market!**

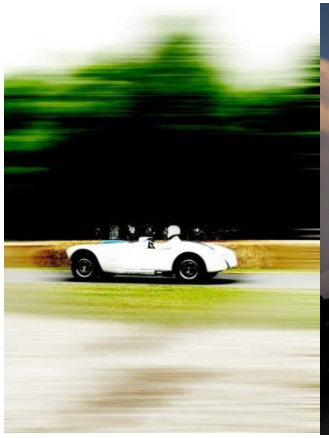


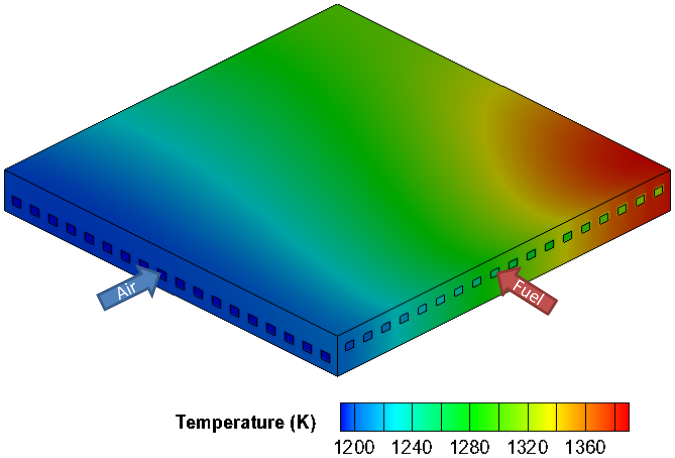




The Applications

- Fossil and Nuclear Power Generation
- Oil & Gas
- Fuel Cells
- Industrial Manufacturing
- Aviation
- Aerospace
- Automotive
- Military





These sensors would enable unprecedented access to new information in real time

Partnership Opportunity

These technologies are available for licensing and/or further collaborative research from the U.S. Department of Energy's National Energy Technology Laboratory.

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