

SENSORS & CONTROLS

Project Fact Sheet



MINIATURE, INEXPENSIVE, AMPEROMETRIC OXYGEN SENSOR

BENEFITS

- Potential to create cost savings of over \$360 million per year, if the low-cost sensor increases combustion efficiency by 5 percent in the industrial, commercial, and residential markets
- Inexpensive for mass production
- Miniature size
- Amperometric currents in the milliamp range
- Sensitivity of oxygen partial pressure to 15 ppm oxygen
- Good repeatability
- Logarithmically linear signal response in the range of oxygen partial pressures found in combustion emissions
- A response time faster than 40 ms

APPLICATIONS

CeramPhysics' amperometric oxygen sensor is primarily applicable to boiler systems. Though the sensor can be used on large and small systems alike, it is particularly appropriate for industrial systems (furnaces, heaters, boilers), as well as commercial and multi-unit and next generation residential systems because of its highly competitive price. The technology is applicable to other combustion systems as well, like those in the automotive and bio-power industries.

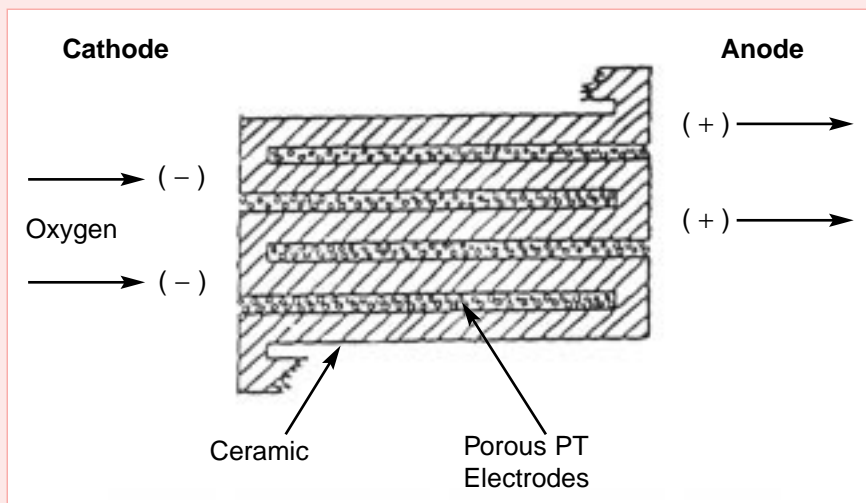
MINIATURE OXYGEN SENSOR COSTS SIGNIFICANTLY LESS THAN CONVENTIONAL SENSORS

Combustion systems are an integral part of industrial and commercial plants and processes. To maintain optimum fuel efficiency, an analysis of the boiler system's combustion by-products is necessary. Measurement of the oxygen partial pressure derived from the boiler exhaust gas is achieved through the use of oxygen sensors, which have been available since the early 1970s. This analysis allows for the optimization of the air-to-fuel ratio and thus lowers energy consumption.

However, current oxygen-sensor technology has limitations. Zirconia sensors, though accurate and reliable, are expensive. Their use is justified in large, industrial applications, but not in smaller-industrial or commercial applications. Also, some sensors available on the lower end of the price scale are unreliable.

In contrast, CeramPhysics' miniature, inexpensive, amperometric oxygen sensor was designed to overcome cost and reliability problems. With a target manufactured price of \$50 each, including the measuring microprocessor, this new technology would be the least expensive oxygen sensor on the market.

MULTILAYER CERAMIC CAPACITOR



CeramPhysics' Amperometric Oxygen Sensor is a multilayer ceramic capacitor, which is ideal for inexpensive mass production and allows for miniaturization of the sensor.



Project Description

Goal: Develop CeramPhysics' amperometric oxygen sensor technology into a packaged system.

The sensor uses a small, multilayer ceramic capacitor structure, consisting of anode and cathode electrodes inside a capacitor body. Oxygen diffusing from the cathode electrode to the anode electrode within the capacitor body produces an amperometric current that is directly related to the partial pressure of oxygen in the surrounding gas. In addition, a platinum track heater is incorporated in the capacitor body for an integrated sensor design.

Two different ceramics can be employed in the technology. A stabilized zirconia will be used in systems over 700°C, while a stabilized bismuth oxide will be used in systems under 700°C. Both sensor types are logarithmically linear in the combustion range, which is a distinct advantage over competing technology. In addition, the technology doesn't require a reference gas, and it consumes only about two watts during operation.

CeramPhysics Inc., developed this new technology with the help of a grant funded by the Inventions and Innovation Program in Department of Energy's Office of Industrial Technologies.

Progress And Milestones

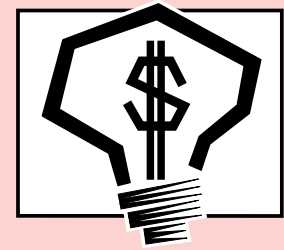
- All work under the Inventions and Innovation grant has been completed.
- CeramPhysics has joined with a strong commercialization partner, Rosemount Analytical, an industry leader in oxygen analyzers and combustion-control systems.
- Protected by U. S. patent 4,462,891. A second patent is pending.

Economics and Commercial Potential

CeramPhysics' amperometric oxygen sensor offers potentially significant economic savings over conventional technology. The integrated sensor itself can be manufactured for less than \$5. Packaged with a microprocessor, the manufactured system price is expected to be less than \$50. In contrast, many existing systems in the industrial market cost more than \$1,500. At this highly competitive price, the technology will be attractive not only to the full industrial market, but also to commercial and multi-unit and next generation residential markets, where oxygen sensors are not commonly used.

The new oxygen sensor's greatest initial potential is with industrial boilers, which have a market size of approximately 50,000 units. The total number of new boilers of all sizes registered annually by the National Board of Boiler and Pressure Vessel Inspectors ranges from 95,000 to 120,000 units. Thus, by accessing the commercial and residential sectors, the technology's market potential is increased tens of thousands of units.

New, low-cost oxygen sensors would allow redundancy in a single measuring probe. When coupled with process control systems, this probe could monitor excess combustion oxygen while self-checking calibration, all at a cost comparable to single sensor probes currently available.



The Inventions and Innovation Program works with inventors of energy-related technologies to establish technical performance and conduct early development. Ideas that have significant energy savings impact and market potential are chosen for financial assistance through a competitive solicitation process. Technical guidance and commercialization support are also extended to successful applicants.

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The Sensors and Controls (S&C) program facilitates the development and delivery of measurement and control technology solutions for the industries involved in the U.S. Department of Energy's Industries of the Future Program.

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