

COMBUSTION PRESSURE SENSOR

Low Cost Device for Improved Fuel Efficiency and Reduced Emissions



Packaged pressure sensor that flush mounts inside the combustion chamber.

Orbital Research Inc. (ORI) is developing a MEMS-based high temperature pressure transducer technology for diesel and turbine engine applications. ORI's high temperature pressure transducer are based on a thin film strain gage configuration using MEMS fabrication techniques and a highly sensitive, novel material thin-film. These technologies combine synergistically resulting in a unique, high temperature sensor with high sensitivity at an affordable price. The transducer's high gage factor (sensitivity) and high temperature capability is significantly greater than competing technologies. These sensors have been demonstrated in the harsh diesel engine environment. (>250,000 cycles)

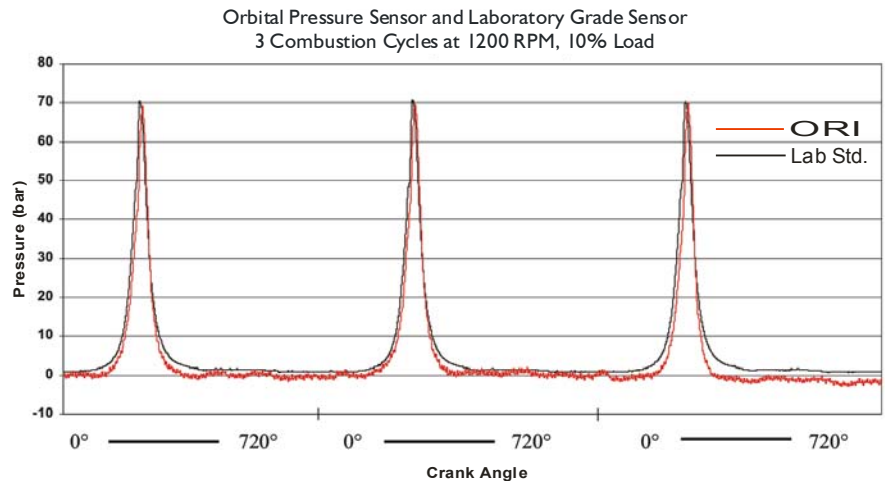
Diesel Engine Application

In this product development program, ORI demonstrated the novel pressure sensor inside a heavy-duty class, Detroit Diesel Series 60 engine at the University of Michigan, Automotive Research Center. In situ test results confirmed excellent correlation between the un-cooled ORI pressure sensor and an adjacent water-cooled laboratory grade sensor. Most noteworthy is the appreciable cost difference between the low-cost ORI sensor and the laboratory grade sensor (approximately \$1000 per unit plus additional hardware costs). The sensor has demonstrated dynamic pressure capability of over 30 kHz.



ORI's High Temperature Pressure Sensor Has Been Tested in a DDC Series 60 Diesel Engine at the University of Michigan Automotive Research Center.

Comparison of the output of Orbital Research's pressure sensor with a laboratory grade water-cooled pressure sensor in Diesel Engine Cylinder.



Turbine Engine Applications

High costs, active cooling requirements and temperature limitations prohibit existing pressure sensor technologies from in-flight use, as well as many ground-based turbine engines. A flight-ready, high temperature pressure sensor with no cooling requirements provides significant potential for advancements in flight capability, engine stability and performance through stall detection, improved thrust, better fuel efficiency, reduced emissions, Active Combustion Control and health monitoring. In a current DARPA funded program, Orbital Research is developing a low-cost, uncooled, high temperature pressure sensor that will be demonstrated in a turbine engine demonstrate the capability for in-flight use. This high temperature pressure sensor, combined with actuators and feedback control, will enable the realization of an “intelligent” engine that can sense a problem and react to prevent or correct the problem.



Design of Packaged High Temperature Pressure Sensor Demonstrated At U of M Engine Test Facility

Performance Targets

Sensor Operation - up to 600°C theoretical without cooling. Demonstrated at 400°C, ongoing development at 500°C

Inexpensive Fabrication - uses commercial MEMS manufacturing processes and equipment.

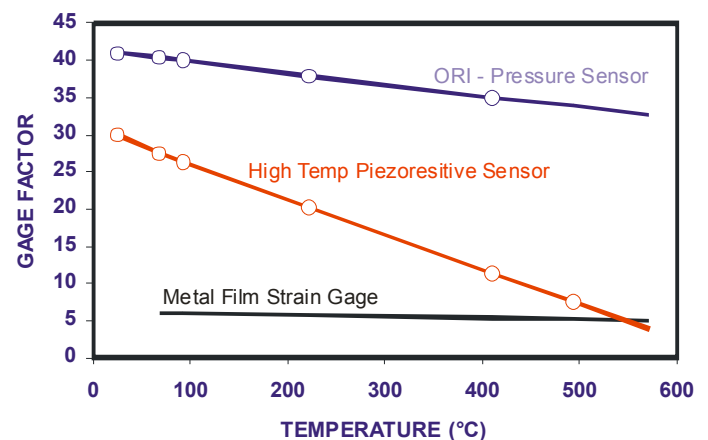
High Sensitivity - 6 to 10x that of metal film strain gage-based pressure sensors maintained to 600°C.

Compact Design - current prototypes made on 2 x 2 mm die with 6-micron line widths.

High Frequency Response - > 30 kHz demonstrated.

Patent Status

U.S. patent 6,622,558 has been granted on this novel high temperature, pressure sensing technology.



Performance of ORI Pressure Sensor vs. Temperature Compared to Competitors

Orbital Research Inc., established in Cleveland Ohio (1991), is a high technology company. Our corporate mission is to develop and commercialize innovative solutions for the transportation, controls and medical industries through leveraging our expertise in MEMS devices and advanced control software. Orbital Research applies these core technologies to solve technical challenges using low cost and commercially viable solutions.