National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Sensors

Combined Pressure and Temperature Sensor for Hot Harsh Environments

Enables Real-time Pressure Measurements, Corrected for Temperature Effects

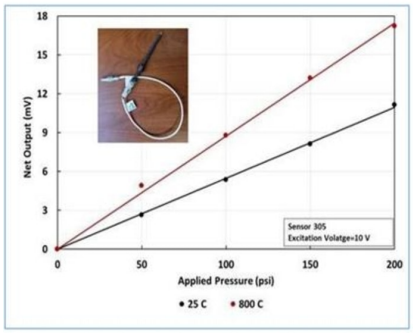
Accurate and reliable pressure data is fundamental for monitoring engine health for the safe and efficient operation of high performance engines. Innovators at NASA's Glenn Research Center have developed a single pressure and temperature sensor system that provides in-situ data in harsh operating environments like combustion. Although current SiC pressure sensors can operate at 800°C inside combustion chambers, the output response is sensitive to temperature changes and requires temperature compensation schemes that rely on a second separate temperature sensor to get a true measure of pressure. The new NASA pressure/temperature (P/T) sensor chip enables real-time translation of pressure and uses only a single tap for two engine measurements. This important sensor system and packaging can provide more accurate data for combustion simulations and to monitor engine health to improve performance and extend the service lifetime of commercial and military aircraft, automotive engines, and power plants.

BENEFITS

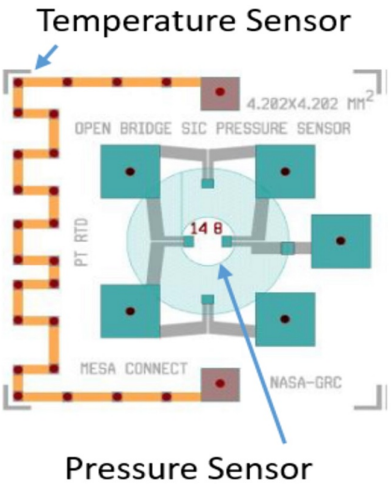
- Direct measurement eliminates the need for lookup tables or temperature compensation techniques.
- Simultaneous on-chip measurement of pressure and temperature improves accurate correlation of results.
- Real-time translation of pressure as function of temperature has been demonstrated to 800°C.
- Use of a single sensorreduces production and assembly costs, and eases path toward IC integration.
- Small footprint allows use of the same pressure tap for both sensors, as opposed to separate taps.

THE TECHNOLOGY

A team of NASA Glenn researchers has developed a portfolio of SiC-enabled electronics and sensors. SiC's ability to function in harsh environments—high-temperature, high-power, high radiation—enables much better performance in many combustion applications. Building on their successful and miniaturized SiC pressure sensor package, the team added a resistance temperature detector (RTD) to the same chip. Having both sensors on a single SiC substrate facilitates the simultaneous measurement of pressure and temperature. The integrated P/T sensors are fabricated with a prescribed sequence of photo lithography and reactive ion etching fabrication steps to create patterns and structures and deposit RTD elements and other layers. Designed to monitor jet engine health, this P/T sensor can be placed directly on the engine, close to the combustion source, for highly accurate, real-time data analysis. As shown in the figures below, the sensor has been tested and characterized for long-term high-temperature stability and response. The data prove that the sensor's performance is repeatable, with negligible hysteresis. Compared to conventional silicon piezoresistive sensors, this new sensor is more viable in high-temperature environments.



This figure shows the net output of the pressure sensor at room temperature and at 800 degrees. The inset shows a prototype sensor unit that was tested.



Both the pressure and the temperature sensor are on a single SiC chip.

APPLICATIONS

The technology has several potential applications:

- Nuclear power: monitors pressure at high temperature
- Aircraft: monitors engine health to control safety and optimize combustion efficiency
- Aerospace: enables feedback control to watch for thermo-acoustic instabilities
- Engine Simulations (general): provides data to validate computational fluid dynamic codes used in engine model prediction

PUBLICATIONS

Patent Pending

technology.nasa.gov

NASA's Technology Transfer Program pursues the widest possible applications of agency technology to benefit US citizens. Through partnerships and licensing agreements with industry, the program ensures that NASA's investments in pioneering research find secondary uses that benefit the economy, create jobs, and improve quality of life.

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More Information

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