Wireless Ceramic Sensors for Gas Turbines

Turbine engines play a prominent role in power generation and aircraft propulsion. The U.S. Department of Energy predicts that by 2020, gas turbines will account for 40% of the U.S. power generation industry. Current turbine designs have been limited by the lack of sensors capable of providing reliable, detailed physical and chemical data at high temperatures (e.g., >1,000°C). Advanced near-zero emission turbine technology currently in development will require a new generation of real-time operational monitoring based on sensors that can withstand the harsh temperatures and conditions involved.

Wireless ceramic temperature and pressure sensors have been developed at UCF to meet that need. These sensors have enhanced sensitivity and can measure and tolerate temperatures >1300°C, and pressures of 300-700 psi.

Technical Details

The enhanced sensor capability is due to nano-structured polymer derived ceramic (PDC) materials, which have excellent thermo-electric properties. Unlike conventional ceramic materials, PDC-based micro-devices can be fabricated using well-developed semiconductor processing technologies. In addition, the cost for fabricating the passive PDC sensors is relatively low due to the small quantities of materials required.

These ceramic materials are incorporated into a MEMS-based device and coupled to a wireless RF antenna. A wireless radio frequency (RF) reader measures changes in an RF resonator based on a physical or environmental parameter. Since the wireless RF reader can be spaced apart from the RF resonator, for high temperature applications the wireless RF reader can be positioned outside the high temperature region. This allows sensing in otherwise difficult to reach sections of a turbine engine, including around the turbine blades.

Benefits

- Small form factor
- Tolerant of high temperatures (>1300°C) and pressures (300-700 psi)
- Enhanced sensitivity
- Able to be coupled to a passive RF antenna for wireless sensing capability
- Low creep rate, high chemical resistance and thermal stability compared to conventional ceramics

Applications

- High-temperature systems such as turbine engines, turbine generators, nuclear power plants, and rockets

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