Temperature and pressure sensors are highly desirable for harsh-environment applications, such as turbine engines. The sensors are required to be robust and survive the harsh-environment consisting of high temperatures above 1000°C, high pressures around 300 psi, and corrosive gases. Wire connection of the sensors is a challenging packaging problem, which remains unresolved as of today. In this dissertation, robust ceramic sensors are demonstrated for high temperature and pressure measurements. Also the wire connection is avoided by using wireless sensor structure based on microwave resonators.

Two types of temperature sensors are realized using integrated resonator/antenna and reflective patch, respectively. Both types of the sensors utilize alumina substrate which has a temperature-dependent dielectric constant. The temperature in the harsh environment is wirelessly detected by measuring the resonant frequency of the microwave resonator. The integrated resonator/antenna structure minimizes the sensor dimension by adopting the seamless design between the resonator sensor and antenna. This integration technique can be also used to achieve an antenna array integrated with cavity filters. Alternatively, the aforementioned reflective patch sensor works simultaneously as a resonator sensor and a radiation element. Due to its planar structure, the reflective patch sensor is easy for design and fabrication. Both temperature sensors are measured above 1000°C.

A pressure sensor is also demonstrated for high-temperature applications. Pressure is detected via the resonant frequency of an evanescent-mode resonator which corresponds to cavity deformation under gas pressure. Compact sensor size is achieved with a post loading the cavity resonator and a low-profile antenna connecting to the sensor. Polymer-Derived-Ceramic is used for the sensor fabrication. The pressure sensor was characterized under various pressures at high temperatures up to 800°C. To facilitate the sensor characterization, a robust antenna is developed in order to wirelessly interrogate the sensors. This specially-developed antenna is able to survive a record-setting temperature of 1300°C.

Major: Electrical Engineering

Educational Career:
Bachelor's of Electrical Engineering, BS, 2006, University of Electronic Science and Technology of China
Master's of Electrical Engineering, MS, 2009, Shanghai Institute of Microsystem and Information Technology, Chinese Academy of Sciences

Committee in Charge:
Xun Gong, Chair, Electrical Engineering and Computer Science
Thomas Wu, Electrical Engineering and Computer Science
Parveen F. Wahid, Electrical Engineering and Computer Science
Vikram J. Kapoor, Electrical Engineering and Computer Science
Linan An, Materials Science and Engineering
Xun Gong, Electrical Engineering and Computer Science

Approved for distribution by Xun Gong, Committee Chair, on October 8, 2013.

The public is welcome to attend.