Development of SiC Gas Sensor Systems

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Silicon carbide (SiC) has high potential as the electronic semiconductor material for a new family of high temperature sensors and electronics. However, in order to reach that potential, a range of technical challenges must be overcome. These challenges go beyond the development of the basic sensor itself and include the need for viable technology to make a complete sensor system: sensor contacts, packaging, and transfer of information from the sensor to the outside world.

An example of such a system is the development of SiC-based gas sensors. SiC-based gas sensors have significant application in the measurement of hydrogen, hydrocarbons, and other gases in widely varied environments ranging from engine emission monitoring, cryogenic propellant leak detection and aircraft fire detection. While the development of the sensor has been challenging, enabling technologies such as high temperature packaging and interconnects are also necessary in order to apply these sensors in, for example, a high temperature engine environment.

This paper will give an overview of the on-going technology development to produce SiC-based gas sensors for a range of aeronautic and industrial applications. It will also review the state of the enabling technology
that is necessary long-term for application of the SiC sensor systems.

The SiC gas sensor development at NASA Glenn Research Center has centered on the fabrication of stable and gas-sensitive Schottky diode structure. While certain structures have shown high promise, long-term durability at high temperature and highly repeatable fabrication of these devices have been problematic. To help realize more durable and repeatable devices, a significant amount of effort has been devoted to understanding the chemistry associated with the SiC/contact interface. A preliminary conclusion of these studies is that control of this interface is necessary, especially early in the “burn-in” period of the sensor at temperatures of 450 C and above.

As work proceeds towards improving long-term durability at high temperatures, the sensor is still operational for a range of lower temperature applications. General packaging and interconnect technologies allow use of the sensor in a range of environments. The use of the SiC-based sensor in engine environments as part of a High Temperature Electronic Nose will be discussed. In the long-term, it is believed that improvements in the SiC semiconductor material itself could have a dramatic effect on the development of SiC gas sensor systems.