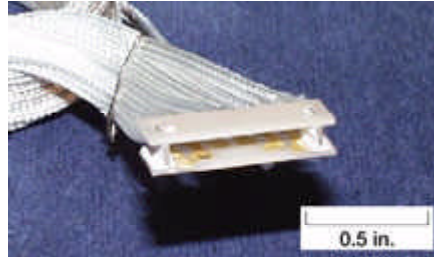


# Packaging Technology Developed for High-Temperature SiC Sensors and Electronics



*Prototype high-temperature electronic package (with test wires) composed of AlN substrate and Au thick-film metallization being developed for SiC sensors and electronic devices.*

A ceramic- and thick-film-materials-based prototype electronic package designed for silicon carbide (SiC) high-temperature sensors and electronics has been successfully tested at 500 °C in an oxygen-containing air environment for 500 hours. This package was designed, fabricated, assembled, and electronically evaluated at the NASA Glenn Research Center at Lewis Field with an in-house-fabricated SiC semiconductor test chip.

High-temperature electronics and sensors are necessary for harsh-environment space and aeronautical applications, such as space missions to the inner solar system or the emission control electronics and sensors in aeronautical engines. Single-crystal SiC has such excellent physical and chemical material properties that SiC-based semiconductor electronics can operate at temperatures over 600 °C, which is significantly higher than the limit for Si-based semiconductor devices. SiC semiconductor chips were recently demonstrated to be operable at temperatures as high as 600 °C, but only in the probe-station environment because suitable packaging technology for sensors and electronics at temperatures of 500 °C and beyond did not exist. Thus, packaging technology for SiC-based sensors and electronics is immediately needed for both application and commercialization of high-temperature SiC sensors and electronics.

In response to this need, researchers at Glenn designed, fabricated, and assembled a prototype electronic package for high-temperature electronics, sensors, and microelectromechanical systems (MEMS) using aluminum nitride (AlN) substrate and gold (Au) thick-film materials. This prototype package successfully survived a soak test at 500 °C in air for 500 hours. Packaging components tested included thick-film high-temperature metallization, internal wire bonds, external lead bonds, and a SiC diode chip die-attachment. Each test loop, which was composed of thick-film printed wire, wire bond, and lead bond was subjected to a 50-mA direct current for 250 hours at 500 °C.

As desired, when soaked at 500 °C with or without current load, the test loops exhibited

low electrical resistance ( $\sim 0.3\Omega$ ). Also as expected, the electrical isolation impedance between printed wires that were not electrically joined by a wire bond remained high ( $>0.4G\Omega$ ) during and after the 500 °C soak. The attached SiC die (diode) showed low resistance ( $< 5\Omega/mm^2$ ) backside electrical contact, at both room temperature and 500 °C, through the die-attachment. These results indicate that the prototype package meets the initial design standards for low-power, long-term, high-temperature operation. This technology is being evaluated and developed further through statistical tests of each packaging element for longer lifetime and higher operation temperatures.

**Find out more about this research <http://www.grc.nasa.gov/WWW/sensors/>.**

**A.Y.T. Corporation contact:** Dr. Liang-Yu Chen, (216) 433-6458,  
Liangyu.Chen@grc.nasa.gov

**Glenn contact:** Dr. Jih-Fen Lei, (216) 433-3922, Jih-Fen.Lei@grc.nasa.gov

**Authors:** Dr. Liang-Yu Chen, Dr. Gary W. Hunter, Dr. Philip G. Neudeck, and Dr. Jih-Fen Lei

**Headquarters program office:** OAST, OSS

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