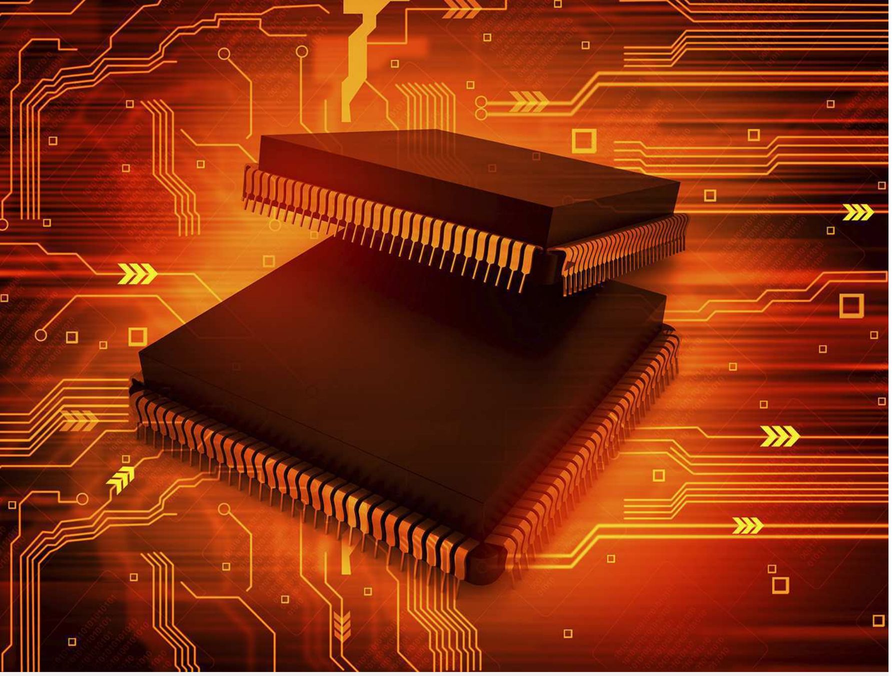


National Aeronautics and
Space Administration

technology solution

Sensors

Silicon Carbide (SiC) Fabrication Method

Speeds production and enables functionality of sensors and electronics beyond 600°C

Scientists at NASA's Glenn Research Center have received several patents for fabrication methods that speed the production of silicon carbide (SiC) sensors and electronics, reduce fabrication costs, and enable advanced semiconductor functionality at temperatures greater than 600°C. Glenn has developed a method for fabricating ultra-thin SiC microstructures using a dopant selective reactive ion etching (DSRIE) technique that can create extremely thin diaphragms (approximately 2 microns), increasing sensor sensitivity and resolution. In addition, Glenn has developed a modular protective packaging that allows SiC-based electronic devices to survive and operate reliably at very high temperatures. These innovations improve the real-time monitoring of high-temperature harsh environments, such as jet and rocket engines, allowing faster response times and more accurate readings.

BENEFITS

- Reliable: Enables SiC sensors to be placed near an engine combustion chamber, improving the fidelity and accuracy of readings
- Low cost: Reduces the complexity and cost associated with conventional fabrication techniques by applying simultaneous ohmic contacts technique
- Robust: Survives and operates reliably in high-temperature environments; packaging method reduces thermally induced stress
- Effective: Extends device functionality and lifetime in high-temperature environments
- State-of-the-art: Can accurately fabricate ultra-thin microstructures as thin as 2 microns

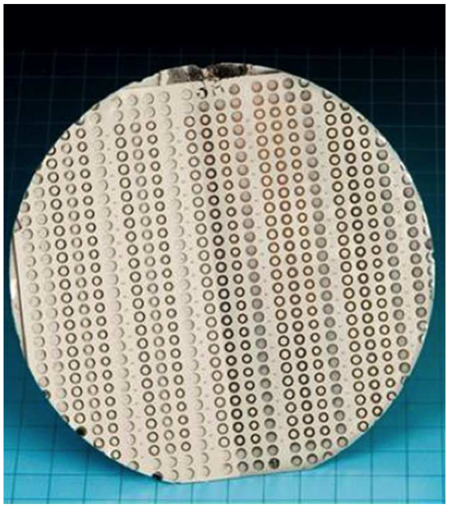
THE TECHNOLOGY

When devices with traditional electrical ohmic contacts are inserted into high-temperature areas, their inability to withstand these temperatures causes their performance to degrade dramatically. As a result, devices with conventional ohmic contact metallization must be located in lower-temperature areas to avoid measurement errors.

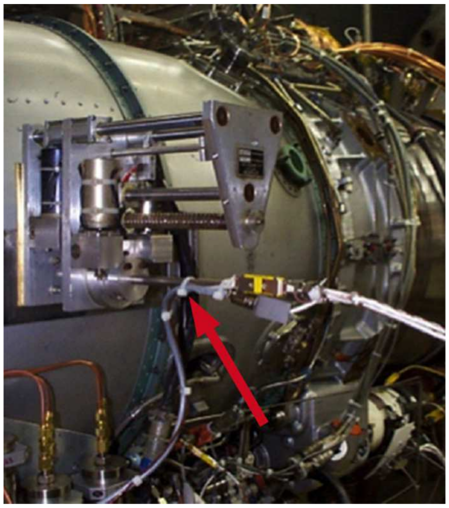
To overcome this challenge, Glenn has developed a SiC fabrication method that allows sensors and electronics to withstand extreme temperatures. Conventional fabrication techniques require multiple time-consuming and costly processes to separately form ohmic contacts onto n- and p-type surfaces. Glenn's innovation creates universal and simultaneous ohmic contacts for both donor and acceptor (n- and p-type) SiC semiconductors. Its unique ohmic contact structure is stable at temperatures greater than 600°C for short duration applications. This breakthrough innovation greatly improves real-time monitoring of high-temperature or other harsh environments.

Glenn has also developed a precision method for fabricating ultra-thin SiC microstructures and diaphragms. Unlike conventional reactive ion etching (RIE), where it is always challenging to obtain SiC diaphragm thickness below 25 microns without punching through, Glenn's dopant selective reactive ion etching (DSRIE) technique allows for a structure thickness of approximately 2 microns. For the first time ever, this allows ultra-thin SiC diaphragms to be fabricated in batches, thereby unlocking the broader capabilities of SiC microelectromechanical systems (MEMS) and nanoelectromechanical systems (NEMS).

In addition, Glenn has created a planar modular package that protects electronics and sensors in high-temperature environments. This packaging can benefit industries that need semiconductor-based sensors and electronics to function optimally in high-temperature, extreme vibration, and corrosive environments.



Batch fabricated array of SiC MEMS diaphragms



Glenn's SiC pressure sensor used in an engine ground test.

APPLICATIONS

The technology has several potential applications:

- Sensors in harsh environments
- Aerospace
- Automotive
- Communications
- Power generation
- Spacecraft
- Oil and gas exploration

PUBLICATIONS

Patent No: 8,373,175; 9,452,926; 9,046,426; 10,067,025

Patent Pending

More Information

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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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