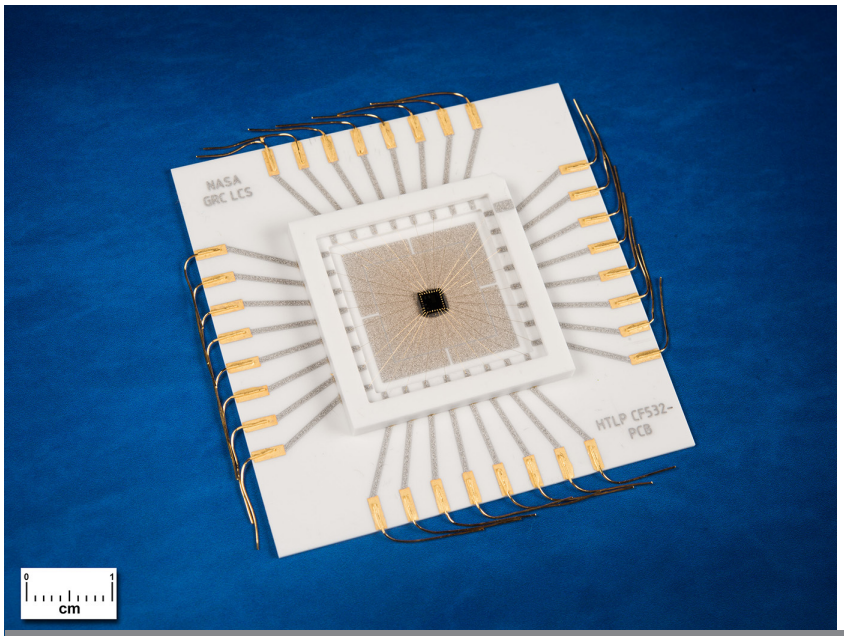


National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Electrical and Electronics

Integrated Circuit Chips

Robust, embeddable logic and mixed signal integrated circuits for extreme environments

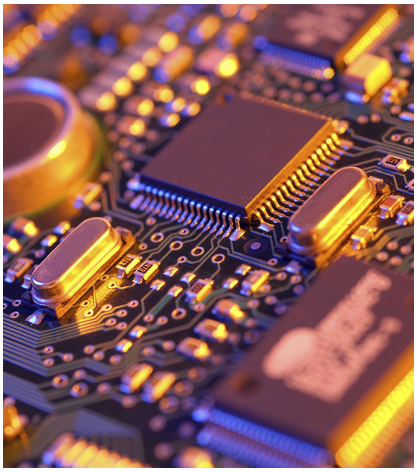
Innovators at NASA's Glenn Research Center have developed a new generation of silicon carbide (SiC) logic and mixed signal integrated circuits (ICs), unprecedented in the field of high-temperature electronics. Previously, SiC ICs could not withstand more than a few hours of 500°C temperatures before degrading or failing. Now, NASA Glenn has successfully fabricated prototypes that consistently exceed 1,000 hours of continuous operation at 500°C. The superior performance stems in part from previous Glenn advancements, such as the iridium interfacial stack (IrIS), a bondable and durable metallization stack that enables electrical packaging connections to SiC integrated circuits operating above 500°C. The enhanced stability of these components will enable important improvements in sensing, control, and operation of harsh environment systems, by providing analog and digital circuit functionality directly where it is needed. This advancement in the manufacturing of SiC-based electronics revolutionizes and broadens the opportunities for intelligent systems by providing ICs that operate well beyond the current temperature limits of conventional (silicon) ICs.

BENEFITS

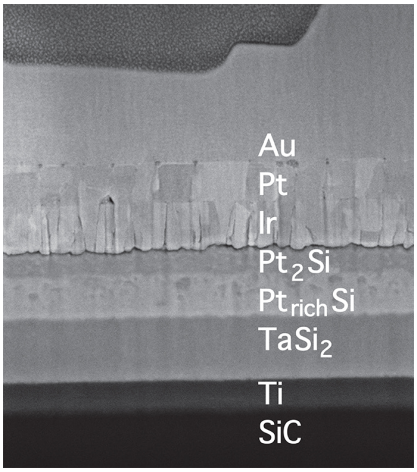
- Robust: Operates at the broad temperature range of -100°C to over 500°C
- Durable: Exhibits prolonged stable operation at 500°C for over 1,000 hours
- Versatile: Offers application-specific digital and analog circuitry that can be uniquely customized
- Simplified: Enables the inclusion of intelligent electronics operating directly in the harsh environment

THE TECHNOLOGY

NASA Glenn's durable, extreme-temperature, integrated circuit chips begin with the replacement of conventional silicon IC transistors with n-channel SiC junction field effect transistors (JFET) and resistors that can reliably function above 500°C. JFETs with the necessary high-temperature stability and electrical gain are fabricated from commercial 4H-SiC wafers with epilayers using dry etching and a self-aligned n-type ion implantation. An innovative circuit approach creates digital logic gates from these normally-on n-channel JFETs and resistors. Using two levels of 500°C durable metal to interconnect numerous SiC gates, complex circuits enabling a variety of control, operation and sensing functions for intelligent systems in harsh environments can be implemented in physically small chips. The challenge of getting electrical signals to and from the chip in a harsh environment is overcome by the use of the iridium interfacial stack (IrIS) that acts simultaneously as a bond metal and diffusion barrier, and can be used on an ohmic contact to the SiC. Combined with Glenn-developed high-temperature durable ceramic chip packaging and harsh environment sensor technology, this revolutionary durable integrated circuit technology is game changing for harsh-environment applications of all types.



Durable integrated circuit chips are particularly useful in high-temperature environments



The Iridium Interfacial Stack is a sequence of sputter-deposited materials (illustrated above)

APPLICATIONS

The technology has several potential applications:

- System monitoring
- Aerospace
- Transportation
- Oil and gas
- Power
- Environmental monitoring
- Robotics
- Commercial space

PUBLICATIONS

Patent No: 7,935,601; 8,841,698; 9,013,002; 7,688,117; 8,416,007; 9,755,645; 9,978,686; 10,490,550; 10,122,363; 10,256,202; 11,004,802

Patent Pending

technology.nasa.gov

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.

LEW-18432-1, LEW-18432-2, LEW-18736-1, LEW-18256-1, LEW-18636-1, LEW-19356-1, LEW-19391-1, LEW-19386-1, LEW-19356-2, LEW-19406-1, LEW-TOPS-33

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NP-2015-04-1512-HQ