Active Project (2016 - 2018)

Extreme Environment Electronics based on Silicon Carbide, Phase II Project

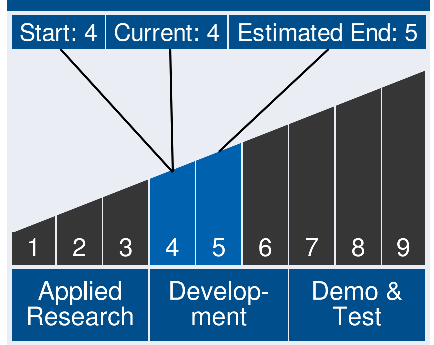
SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

Radiation tolerant, extreme temperature capable electronics are needed for a variety of planned NASA missions. For example, in-situ exploration of Venus and long duration Europa-Jupiter missions will expose electronics to temperatures up to 500 �C and radiation of 3 Mrad (Si) total dose. During this program, United Silicon Carbide will extend the capability of its SiC JFET integrated circuit (IC) fabrication technology to produce electronics compatible with such extreme environments. Silicon Carbide (SiC) junction field effect (JFET) based electronics are ideal for these environments due to their radiation tolerance and their high performance and reliability over an extremely wide operating temperature range. SiC electronics can be used in applications ranging from low power, low noise mixed signal electronics for precision actuator control, sensor interfaces, and guidance and navigation electronics to power electronics for power management and distribution and power processing units. SiC based electronics will have longer storage and operating lifetimes when compared to existing silicon electronics. Use of SiC integrated circuits will also lower system mass, volume, and power by reducing or eliminating the need for cooling and radiation shielding. In Phase I, we showed the feasibility of our approach by measuring SiC JFET IC device characteristics at 500 �C; performing a 500 hour, 500 �C reliability test; and using TCAD simulations to further explore the devices behavior at high temperature and when subjected to radiation. In Phase II, we will fully develop the extreme environment capable SiC IC fabrication technology and use it to fabricate an integrated circuit which will be characterized at 500 �C and before and after radiation exposure. Following Phase II, we will provide access to the process technology and related design intellectual property through a commercial fabrication service so that NASA and others can fully leverage its capability.

Table of Contents

Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: Extreme environment electronics based on SiC are capable of operation in the extreme radiation and temperature conditions that will be encountered during exploration of the solar system on missions such as the planned Venus In-Situ Explorer and proposed Europa-Jupiter missions. SiC IC technology developed in this program can also be used with existing discrete SiC power devices to implement scalable, high operating temperature, radiation hard power management and distribution systems and power processing units for satellites and other spacecraft. Earth based applications include distributed engine control systems. These systems have been the subject of research and development for several decades but their implementation has been prevented by the lack of available extreme temperature electronics technology. The commercially viable, high temperature capable electronics technology developed in this program will fill this need leading to new research and ultimately a new generation of engine controls for improved aircraft performance and efficiency.

To the commercial space industry:

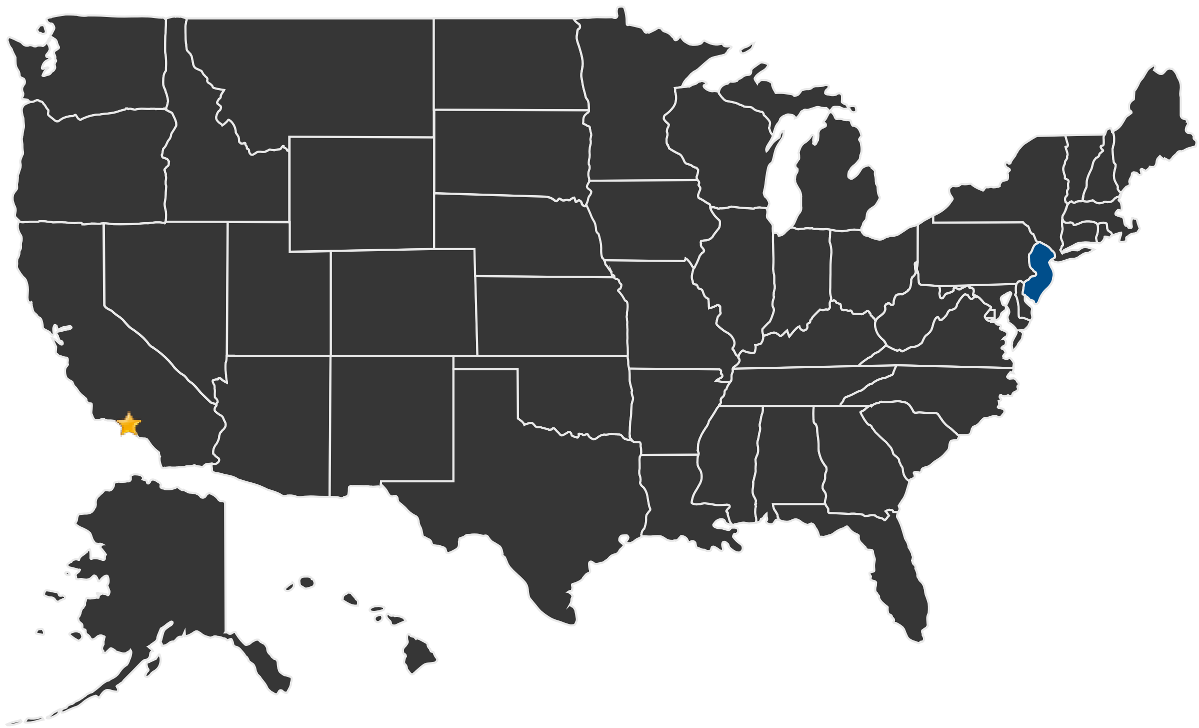
Potential Non-NASA Commercial Applications: Extreme environment electronics also have applications in the areas of defense, aerospace, scientific research, energy exploration, and industrial controls. DoD needs radiation tolerant electronics for space and missile defense applications and high temperature electronics for electronic aircraft controls being developed to replace hydraulic systems. Distributed engine control developments enabled by SiC electronics have direct applicability in commercial jet engines where there is a continual push for increased fuel efficiency. Scientific applications include nuclear physics research and instrumentation for nuclear facilities. High temperature electronics are needed for improved downhole tools for geothermal energy exploration, development,

Management Team *(cont.)*

Principal Investigator:
- Matthew O'Grady

and production. There is also a well-established market for extreme temperature pressure sensors in which SiC electronics can increase performance by buffering the sensor signal within the high temperature environment.

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Jet Propulsion Laboratory

Other Organizations Performing Work:

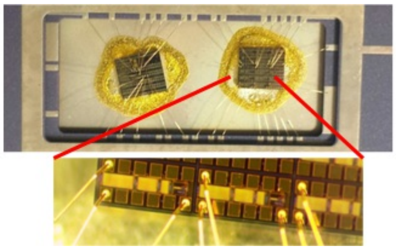
- UNITED SILICON CARBIDE, INC. (Monmouth Junction, NJ)

PROJECT LIBRARY

Presentations

- Briefing Chart
    - (http://techport.nasa.gov:80/file/23127)

IMAGE GALLERY



Extreme Environment Electronics based on Silicon Carbide, Phase II

DETAILS FOR TECHNOLOGY 1

Technology Title

Extreme Environment Electronics based on Silicon Carbide, Phase II

Potential Applications

Extreme environment electronics based on SiC are capable of operation in the extreme radiation and temperature conditions that will be encountered during exploration of the solar system on missions such as the planned Venus In-Situ Explorer and proposed Europa-Jupiter missions. SiC IC technology developed in this program can also be used with existing discrete SiC power devices to implement scalable, high operating temperature, radiation hard power management and distribution systems and power processing units for satellites and other spacecraft. Earth based applications include distributed engine control systems. These systems have been the subject of research and development for several decades but their implementation has been prevented by the lack of available extreme temperature electronics technology. The commercially viable, high temperature capable electronics technology developed in this program will fill this need leading to new research and ultimately a new generation of engine controls for improved aircraft performance and efficiency.