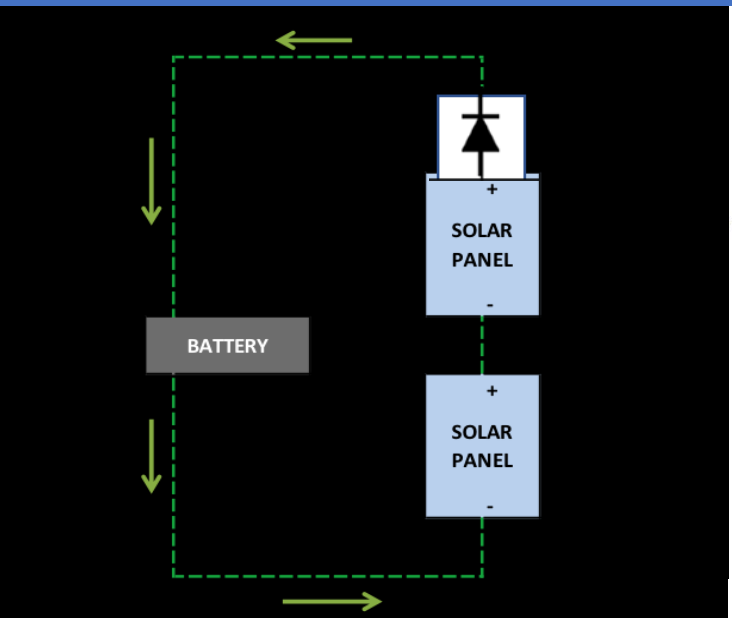
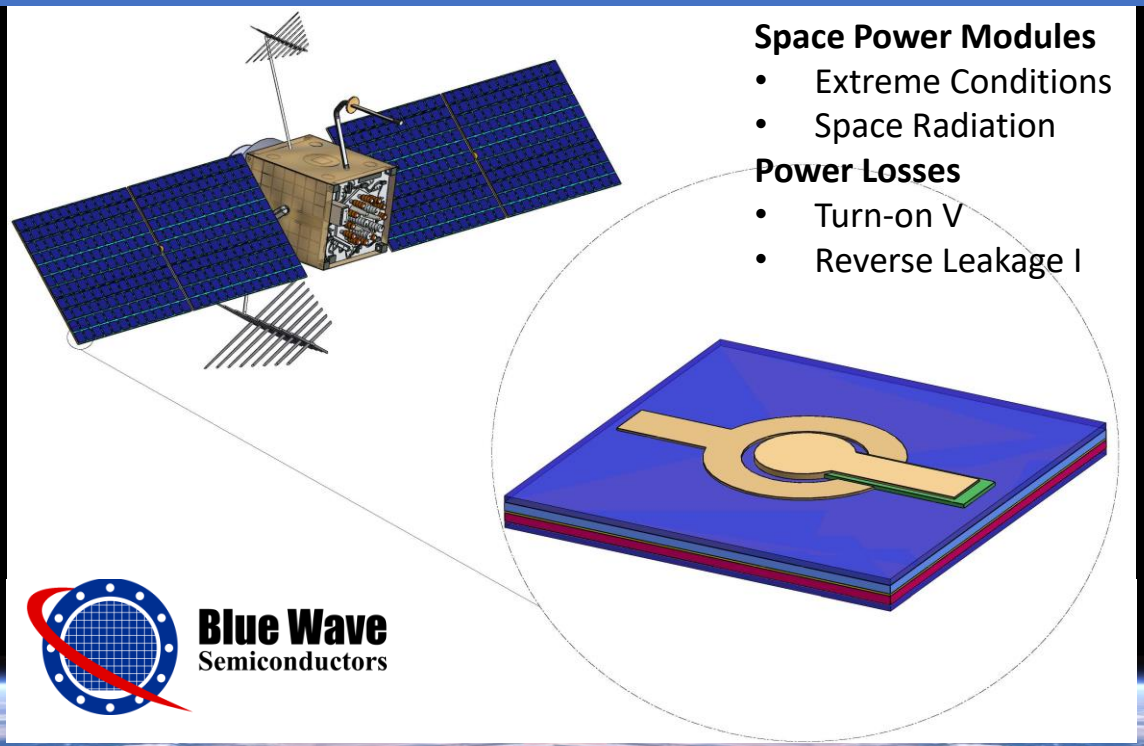
Wide Band Gap Heterojunction Radiation Hard Diode Technology for Space Power Applications

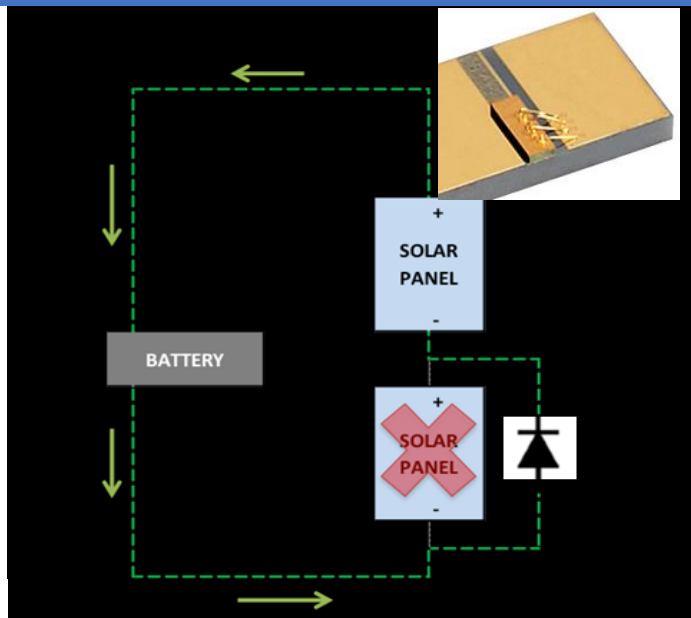


Blocking diode in solar array



Space Power Modules
- Extreme Conditions
- Space Radiation

Power Losses
- Turn-on V
- Reverse Leakage I

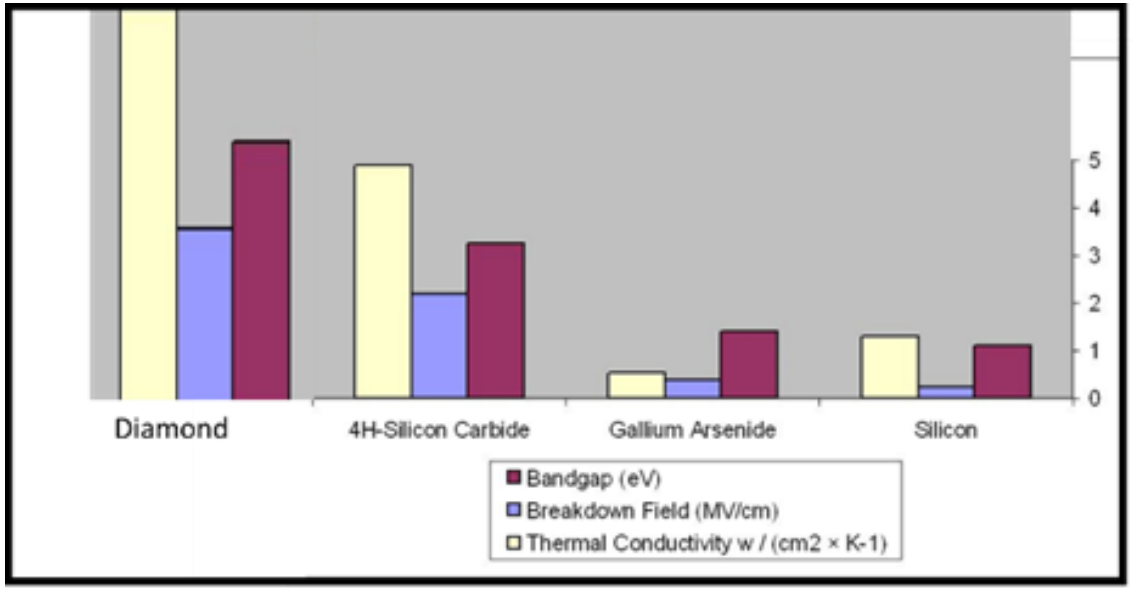


Bypass diode in solar array

Ratnakar D. Vispute, Blue Wave Semiconductors, Baltimore MD USA

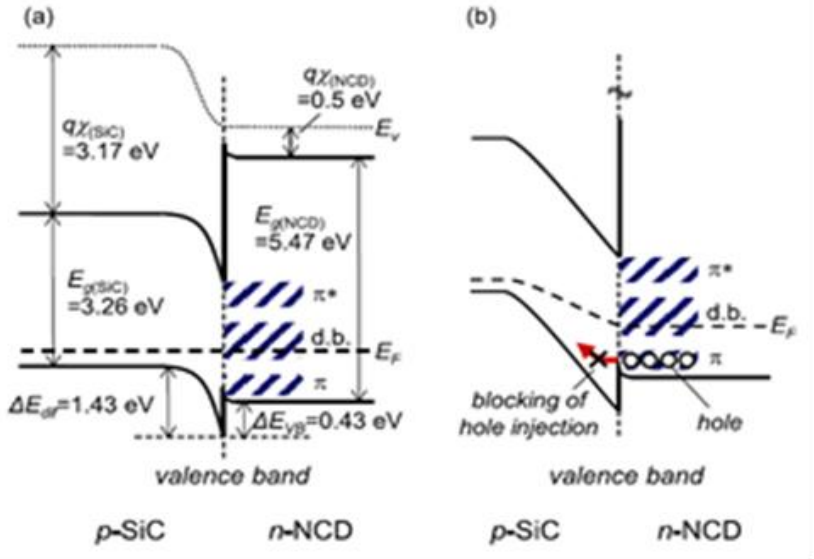
AFRL SBIR PHASE II: CONTRACT NUMBER# FA864920C0284

Radiation Hard Electronic Materials: Approach and Methodology

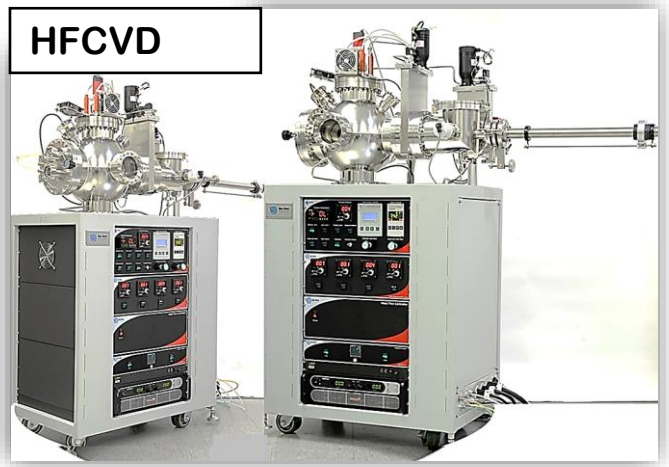


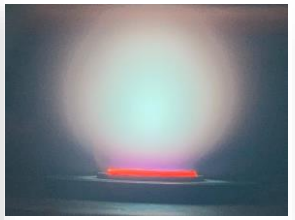
SiC and Diamond: Ideal materials for high-voltage & high-temperature operations.

1. Diamond and SiC are wide-bandgap materials: Diodes can operate at higher temperatures than Si, Ge, GaAs.
2. Breakdown fields of diamond and SiC (ten times than Si): High-voltage Schottky diode possible.
3. High thermal conductivity of diamond and SiC than Si & GaAs: Enables fabrication of higher-current/high power diodes.

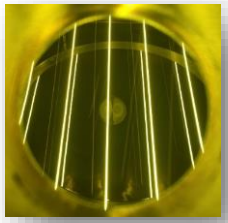


Predicted energy-band diagrams of the n-NCD/p-SiC diode in (a) thermal equilibrium and (b) reverse bias condition; qv: electron affinity, Eg: band gap, Ev: vacuum level, EF: the Fermi level [Ref. M. Goto et.al., APL 104, 153113 (2014)].





Microwave Chemical Vapor



Hot Filament Deposition

Nanodiamond 4” Si

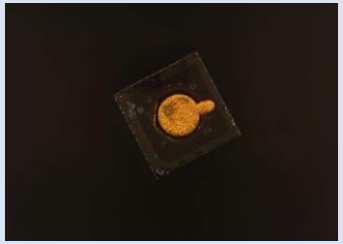
Results: Low Turn-on, High reverse voltage, H.T. Annealing Characteristics

Metal, Si, Ge

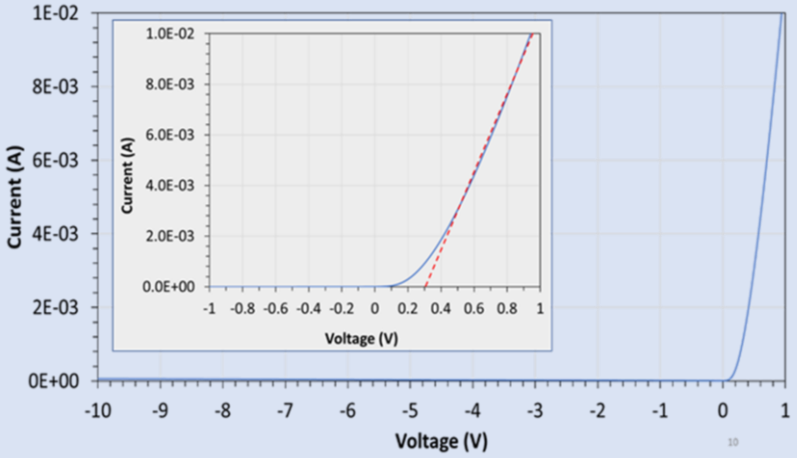
CVD Diamond, SiC

New Junctions Hi power handling Capacity

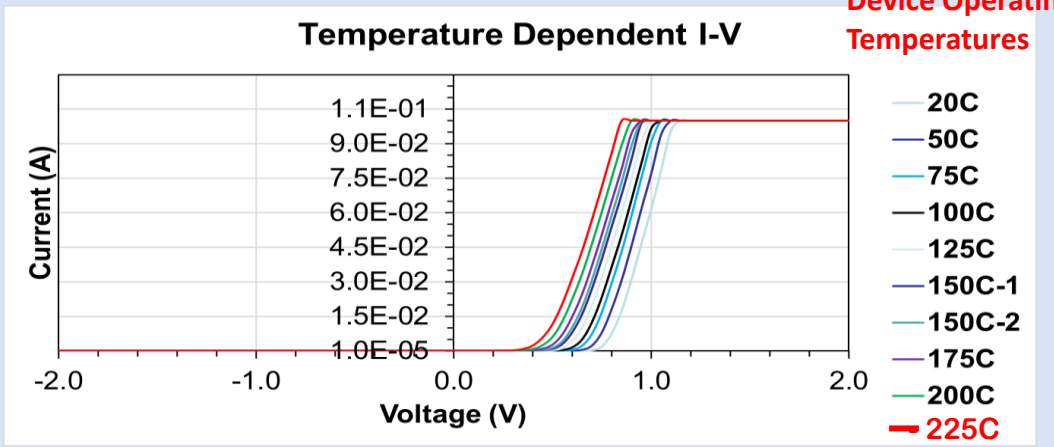
Large Area WBG Diode



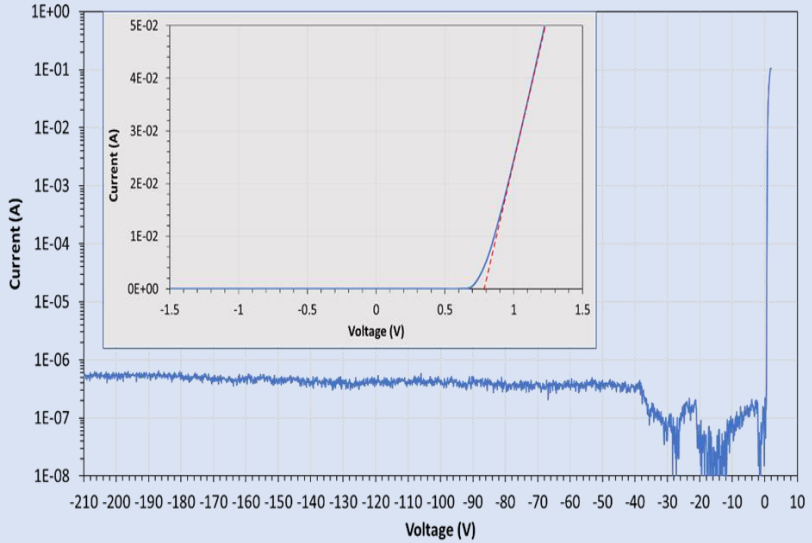
Metal/WBG



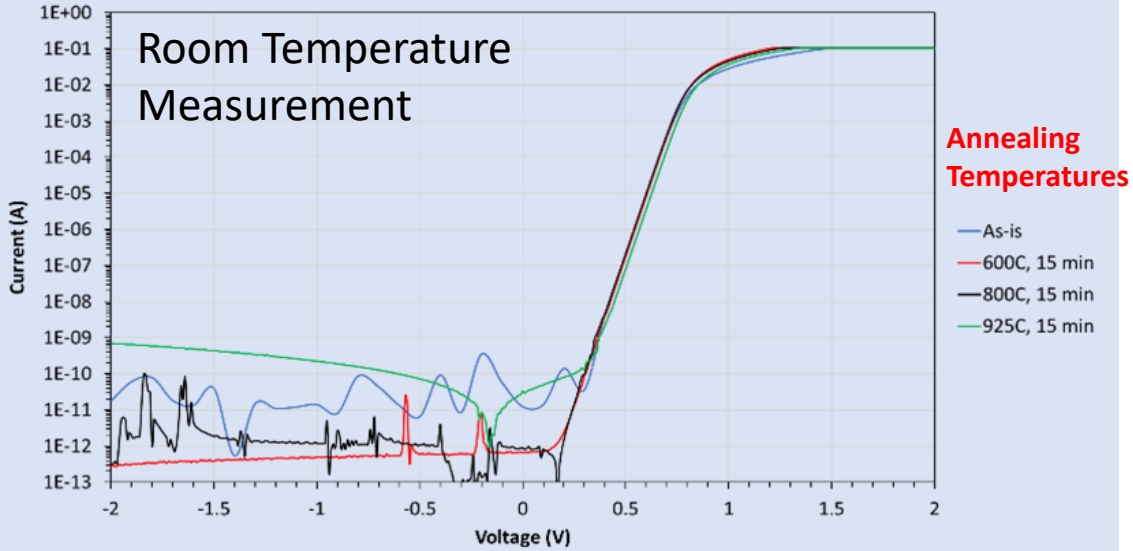
I-V characteristics of Metal/CVD Diamond



Temp Dependent I-V Characteristics of Metal/SiC



I-V Characteristics of Metal/SiC



Annealed High Temperature: I-V Characteristics of Metal/SiC

High energy Electron and Proton Beam irradiation of heterojunctions diodes are in progress.

Summary

Test Standards
Electrical load and Cycling
Radiation Exposure
Forward Bias and Reverse Bias Test conditions
Humidity test/ Reactive Atmosphere/Atomic Oxygen
Thermal Cycling
Thermal Shock Resistance Characteristics

Commercialization: New Diodes for Efficient Space Power Electronics

- We are developing WBG materials-based heterojunction diodes suitable for space power applications: Low turn-on voltage diode for solar cell bypass & Schottky diode for HV voltage blocking.
- Further advancement and performance improvements in these devices will provide AFRL enabling technology in advancing space power solar cell panels.
- Contact: RD Vispute, E-mail: rd@bluewavesemi.com, Phone 1 (301) 706 8833.