

DIAMOND MATERIAL SET TO REVOLUTIONIZE THE POWER ELECTRONICS INDUSTRY

**Based on Frost & Sullivan materials*

In wide-bandgap (WBG) material research, diamond material has been a unique material for electronic device and electronic applications due to its ability to conduct heat 5 times more than copper and insulate very high voltages across very thin layers of the material. The need for diamond devices has increased, particularly for high-power devices, because of their electrical resistivity and heat dissipation competences. Moreover, diamond has the potential to replace gallium (Ga) and silicon (Si) in high-voltage and high-temperature applications.

Properties of Diamond Material

- Diamond has a high thermal conductivity when compared to silicon, silicon carbide (SiC), gallium nitride (GaN) and gallium arsenide (GaAs). This will conduct heat away from the active region immediately, thereby delivering high output performance from a given size of device.
- Diamond is a wide bandgap material and is used as a substrate for electronic devices. Diamond transistors will be fabricated to realize high-power applications that are not feasible using GaN and SiC transistors.

Fraunhofer Institute demonstrated that the GaN transistors with diamond substrates withstood current up to 100 amperes during stress testing, indicating the thermal strength and short circuit resistance of the novel GaN devices. Akash Systems Inc., is a US-based startup that specializes in manufacturing Radio Frequency (RF) and Monolithic Microwave Integrated Circuit (MMIC) power amplifiers based on its proprietary GaN-on-Diamond wafer technology. Akash has successfully designed mini satellites called CubeSats using GaN-on-Diamond transmitters. Micron Semiconductor Ltd., a UK-based company has developed synthetic diamond detectors that can be used for high-energy physics, neutron detection, medical therapy, and dosimetry as well as monitoring beam losses. Diamond Microwave Devices Limited, a UK company, in collaboration with the London Centre for Nanotechnology at University College London (UCL) is developing novel diamond transistor technology and holds several patents related to diamond transistor structures.

Application Scenario of Diamond Material

Power semiconductors developed from diamond materials can support numerous mission-critical applications, such as transmission and distribution of generated

electricity, RADAR, electronic warfare systems, and object/people screening. However, in the current scenario, market participants are working on cost-effective processing technologies for performance improvement and technology development is in the R&D phase.

Key Companies Operating in the Diamond-based Semiconductor Devices Segment

Evince Technology Ltd., Inseto, and INEX Microtechnology are some of the key companies across the globe operating in the diamond domain. A few promising start-ups, such as AKHAN Semiconductor Inc. and Element Six are also entering the diamond semiconductor market with their unique product offerings.