Diamond On Nanopatterned Substrates

Tech ID: 30207 / UC Case 2018-867-0

SUMMARY

UCLA researchers in the Department of Materials Science and Engineering have developed a nanofabrication method for improving the thermal properties of polycrystalline diamond films grown by chemical vapor deposition.

BACKGROUND

Synthetic polycrystalline diamond grown by chemical vapor deposition (CVD) is used to thermally manage high power electronic components, which improves the performance and reliability of such components. Single crystals of diamond have the highest known thermal conductivity of any material, but their high cost limits their practical application in thermal management. Polycrystalline diamond plates can be grown in large areas, and thick (> 100 μm) plates can achieve thermal conductivities approaching that of single crystal diamond. However, these polycrystalline diamond films have lower thermal conductivities due to grain size and 'texture' or orientation of the grains. Therefore, there is substantial interest in improving the thermal conductivity of thin (< 10 μm) diamond films for integration into high power electronics devices.

INNOVATION

UCLA researchers have developed a technique for growing polycrystalline diamond films with improved thermal properties. This innovation manipulates the diamond grain growth on the nano-scale by introducing a patterned substrate, which induces a particular orientation during growth. This texturing during growth enhances the diamond film's thermal conductivity. The nanopatterned films have approximately 30% higher thermal conductivity and as much as 44% decrease in thermal resistance. Moreover, the substrate for growing diamond films need not be silicon and should work on arbitrary substrates with nanopatterned features. The fabrication methods are also compatible with commercially available fabrication techniques.

APPLICATIONS

- Thermal management in high power electronics (inverters, transformers, etc.)
- Heat sinks
- Electronic materials integration
- Integrated circuits

ADVANTAGES

- ~30% higher thermal conductivity
- As much as 44% decrease in thermal resistance
- Can be applied to other substrates and surfaces with nanopatterned features
- Compatible with commercially available fabrication techniques

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Issued Patent	11,131,039	09/28/2021	2018-867

Additional Patents Pending

RELATED MATERIALS

CONTACT

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OTHER INFORMATION

KEYWORDS

polycrystalline diamond, chemical vapor deposition (CVD), nanopatterned substrate, textured growth, high power electronics, thermal management, thermal resistance, materials integration

CATEGORIZED AS

- **Nanotechnology**
- Electronics
- **Semiconductors**
- Assembly and Packaging
- Design and Fabrication
- Processing and Production

RELATED CASES

2018-867-0

▶ Cheng, Z., Bougher, T., Bai, T., Wang, S.Y., Li, C., Yates, L., Foley, B.M., Goorsky, M., Cola, B.A., Faili, F. and Graham, S., 2018. Probing Growth-Induced Anisotropic Thermal Transport in High-Quality CVD Diamond Membranes by Multifrequency and Multiple-Spot-Size Time-Domain Thermoreflectance. ACS applied materials & interfaces, 10(5), pp.4808-4815.

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

▶ Selective Deposition Of Diamond In Thermal Vias

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