

## **Diamond - Semiconductor Integration - The Challenge of Thermal Expansion Mismatch**

Diamond is key science and engineering material for heat sinking of electronic and opto-electronic devices. Recent successes include the integration of diamond with GaN, to enable high power microwave electronic devices, the Centre for Device Thermography and Reliability (CDTR) at the University of Bristol and Element-Six have been leading internationally. One of the key challenges to achieve the integration of diamond with semiconductors is the large mismatch of the coefficient of thermal expansion (CTE) of diamond to most materials.

The objective of this PhD is to research and develop novel solutions to address this critical issues. This will enable to develop next generation and world-leading thermal performance diamond heat-spreaders and high reliability packaged chips. The project would include modelling, experimental work and testing to validate results, including physics and engineering research fields. The intrinsic difference between the CTE of diamond to the common semiconductors (i.e. Si, GaAs, GaN) used for high power density electronics (e.g. high brightness LEDs, high power LDs, RF power amplifiers, power switches) and with diamond the heat-spreading material currently means that a trade-off exists between thermal performance and reliability which limits the overall benefit and value proposition of diamond heat-spreaders, and is one barrier to diamond to entry in the high power packaging industry. This research project therefore has the potential for a major research impact on the international scale.

This project will be performed in collaboration with Element Six Ltd, who are co-funding this PhD. The PhD student would also benefit from a recently awarded EPSRC Programme Grant led by the Professor Kuball, Head of the CDTR at the University of Bristol on the development on step-changing GaN-on-diamond electronic device technology. The CDTR is active in many EU, US, and UK research programmes, and is funded by the UK Engineering and Physical Sciences Research Council (EPSRC), the US Defence Advanced Research Projects Agency, the European Space Agency and other funding agencies, as well as by Industry.

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