BETR Solid State Technology and Devices Seminar

Friday, April 26, 2024

BEOL-Compatible Thin-Film Diamond for Thermal Management in Si and III-Vs

Srabanti Chowdhury

Associate Professor, Electrical Engineering & Materials Science and Engineering
Senior Fellow at the Precourt Institute for Energy
Stanford University

Abstract: The increasing demand for higher power density in electronic applications, from computing to RF electronics, requires efficient device designs and circuit architectures. Despite significant innovations, high junction temperatures caused by device self-heating continue to compromise both performance (efficiency and power density) and device longevity. Over the past six years, our research group has diligently pursued the development and integration of low-temperature diamond achieving significant results in both Silicon and III-V semiconductor technologies. The growth of high-quality diamond films at temperatures ranging from 400 to 500 °C, while preserving sp3-like properties along with a pivotal innovation in interlayer technology has resulted in remarkably low thermal boundary resistance, and exceptionally high thermal conductivity, surpassing that of copper. When integrated into GaN High Electron Mobility Transistors (HEMTs), the application of diamond films has demonstrated a remarkable reduction in channel temperatures by up to 70 °C at a DC power output of 25 W/mm. Furthermore, we have successfully extended the application of this low-temperature diamond growth technique to Silicon substrates, achieving compatibility with back-end-of-line (BEOL) processes.

Bio: Dr. Srabanti Chowdhury is an associate professor of Electrical Engineering department and (by courtesy) Materials Science and Engineering at Stanford University. She specializes in the wideband gap (WBG) and ultra-wide bandgap (UWBG) materials and device engineering and her research focuses on energy-efficient system architecture for power and RF applications, particularly emphasizing thermal management. She earned her M.S. in 2008 and Ph.D. in 2010 in Electrical and Computer Engineering from the University of California, Santa Barbara. In recognition of her outstanding work on diamond integration with GaN and SiC, resulting in very low thermal boundary resistances for thermal management, Prof. Chowdhury received the 2023 Technical Excellence Award from the Semiconductor Research Society (SRC). Her achievements also include the 2020 Alfred P. Sloan Fellowship in Physics and the 2016 Young Scientist Award at the International Symposium on Compound Semiconductors (ISCS). Earlier in her career, she was honored with the DARPA Young Faculty Award, NSF CAREER Award, and AFOSR Young Investigator Program (YIP), all in 2015. Prof. Chowdhury's significant contributions to the field encompass 6 book chapters, 120 journal papers, 150 conference presentations, and 26 issued patents. Actively engaged in IEEE conference committees, including IRPS and VLSI Symposium, she serves on the executive committee of IEDM. Since 2021, she has been a senior fellow at the Precourt Institute for Energy at Stanford. Notably, she became an IEEE fellow in the batch of 2024 for her contributions to wide bandgap semiconductor devices and technology.