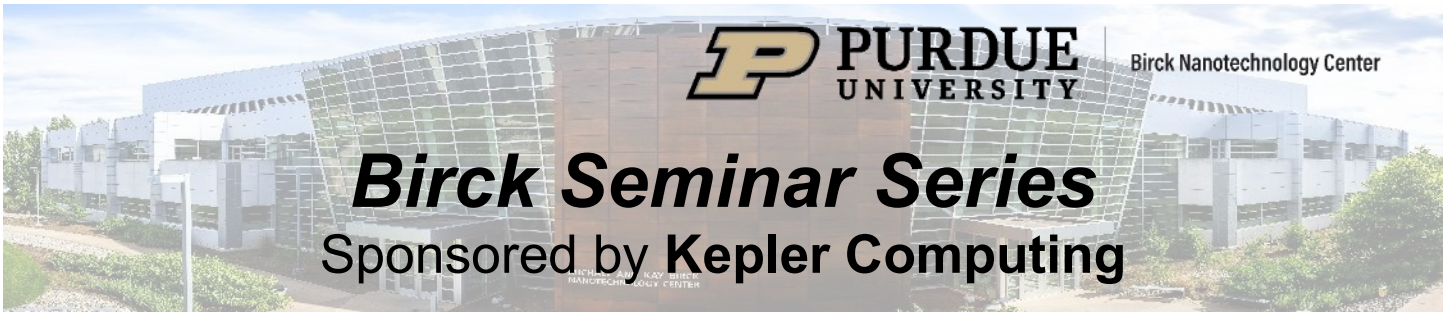

Materials Challenges for Heterogeneous Integration and Advanced Packaging

Shubhra Bansal
School of Mechanical Engineering, School of Materials Engineering

Wednesday, Apil 16th @ 2:00 pm in BRK 1001
Coffee and snacks served before seminar
also on MS teams link

Abstract: Historically Moore's Law and Dennard Scaling has driven exponential performance gains with transistor scaling. To meet the continued computing demands, advanced semiconductor packaging through 3D heterogeneous integration of specialized components (logic, memory, analog, photonics) is critical. 3D heterogeneous integration requires multidisciplinary material advances in dielectrics, high density high bandwidth interconnects, power delivery and thermal management. Manufacturing advances such as through-vias (TSV, TGV) and hybrid bonding have enabled ultra-high interconnect densities of 108/mm3 (# of verticals and # of lines), however, key materials and reliability challenges remain. Technology grand challenges in advanced packaging for AI include low-thermal budget Cu-to-Cu bonding, integration of low-latency optical interconnects and thermal management with power density as high as 1 kW/cm2.
In this presentation, I will first discuss an overview of materials challenges for enabling 3D heterogeneous integration namely (1) high density functional substrates (2) ultra-low-k photo imageable dielectrics (3) materials for thermal management (and thermal isolation for near or in-memory solutions), and (4) high-bandwidth, low-latency interconnects. Secondly, I will share our latest research on (1) development of high-bandwidth interconnects through integration of 2D materials and topological insulators, (2) materials design to enhance electromigration lifetime for high current density interconnects, and (3) novel methods of hot-spot management with integration of on-chip multijunction thermo-photonic perovskite coolers.

Bio: Shubhra Bansal is an Associate Professor at Purdue University with a joint appointment in School of Mechanical Engineering and School of Materials Engineering. She holds B.Tech. degree in Metallurgical and Materials Engineering from the Indian Institute of Technology, Roorkee. She received her M.S. and Ph.D. in Materials Science and Engineering from Georgia Institute of Technology, focusing on development of high-density ceramic substrates and nanocrystalline Cu-pillar chip-to-package interconnects at the pioneering GT-Packaging Research Center with Prof. Rao Tummala. Her professional career began at GE Global Research following which, she served as a Senior Technical Advisor for President Obama's SunShot Initiative at the Department of Energy. Prior to joining Purdue in 2023, Dr. Bansal was an Associate Professor in Mechanical Engineering at University of Nevada Las Vegas. Her research interests include novel materials, reliability and sustainability for renewable energy and semiconductor packaging applications. She is a senior member of IEEE and currently serves as the Associate Editor of IEEE- Journal of Photovoltaics and TCPMT, and Elsevier Solar Energy Journal. At Purdue, she also leads the Heterogeneous Integration and Advanced Packaging technical vertical for SCALE- a DoD funded workforce development program.

Host: Neil Dilley, Research Manager | Email: ndilley@purdue.edu