

Keynote Talk, Center for 2D and Layered Materials and 2D Crystal Consortium 2022 Graphene and Beyond Workshop, Penn State, May 18-19, 2022.

Sustaining Moore's Law (and Beyond) with 2D Materials

Kaustav Banerjee

University of California, Santa Barbara

Abstract: Two-dimensional (2D) van der Waals materials such as graphene, h-BN, and various transition metal dichalcogenides (such as WS_2 , WSe_2 and MoS_2) exhibit a wide range of remarkable properties that can be exploited for a number of applications, including sub-5 nm field-effect transistors. I will bring forward a few applications uniquely enabled by 2D materials and their heterostructures that have been demonstrated in my lab for overcoming fundamental limitations in microelectronics miniaturization. I will also discuss the prospects of building a revolutionary new class of monolithic-3D integrated circuits of ultimate thinness and integration density using atomically-thin 2D materials that offer a possible pathway to extend Moore's law indefinitely into the future as well as unprecedented beyond-Moore heterogeneous integration and energy-efficiency, highlighting both opportunities and challenges.



Kaustav Banerjee is Professor of Electrical and Computer Engineering at the University of California, Santa Barbara, and is one of the world's leading innovators in the field of nanoelectronics. Initially trained as a physicist, he graduated from UC Berkeley with a PhD in electrical engineering in 1999. Prof. Banerjee has made seminal contributions in nearly every aspect of nanoelectronics, and his ideas and innovations have played a decisive role in steering worldwide research. His research into energy-efficient electronics, including nanoscale interconnects, 3D ICs, and thermal-aware IC design, has found wide scale implementation in the semiconductor industry. His pathbreaking innovations with two-dimensional (2D) van der Waals materials and heterostructures are setting the stage for next-generation electronics. This includes the invention of the *Kinetic Inductor* using graphene that overcame a 200-year old limitation, and has been called "[a trillion dollar breakthrough](#)" by the *Forbes* magazine. Prof. Banerjee is a Fellow of IEEE, the American Physical Society, Japan Society for the Promotion of Science, and AAAS, and has been recognized with numerous awards and honors including the Friedrich Wilhelm Bessel Research Award from the Alexander von Humboldt Foundation, Germany, and the 2015 Kiyoo Tomiyasu Award—one of IEEE's highest honors. In 2019, he was identified as one of the world's most influential scientific minds by Clarivate Analytics. In 2021, he co-founded Destination 2D Inc., the first company commercializing the tools and processes for integrating graphene and other 2D materials in CMOS technology based on his pioneering research with these materials.