THE MATERIALS SCIENCE AND ENGINEERING DEPARTMENT
FALL COLLOQUIUM SERIES PRESENTS:

# Professor Kunal Mukherjee

Assistant Professor of Materials Science Engineering

**Stanford University**

## *From Dislocations to Luminescence: Heteroepitaxy of Dissimilar Semiconductors for Infrared Optoelectronics*

**Integrating dissimilar semiconductors** on a single crystalline platform could enable the next generation of devices for optical communication and sensing. Materials such as III-V and chalcogenide semiconductors, when epitaxially integrated with established platforms, offer distinct optoelectronic properties that expand the capabilities of conventional technology. However, integrating crystals with structural and chemical mismatches introduces extended crystal defects such as dislocations, making this a significant materials science challenge. *A key theme of this talk is that integrating dissimilar semiconductors need not come at the expense of function. Materials and device design can instead be used together to control how mismatch is accommodated while preserving performance.*

In this talk, I will first show how understanding dislocation dynamics led us to design more defect-tolerant III-V telecom lasers on silicon. By combining alloy hardening with InAs quantum dots, we realized lasers 100× more reliable than prior state-of-the-art devices. I will then contrast this approach with IV-VI semiconductors such as PbSe, in which we demonstrate innate tolerance to high dislocation densities while maintaining efficient infrared light emission at wavelengths spanning 3–8 μm for sensing applications. I will conclude with anisotropic chalcogenides, where we developed heteroepitaxial approaches to preserve optical anisotropy in SnSe and accommodate large structural changes across coherent phase boundaries for reconfigurable photonics. By understanding how mismatch can be accommodated and how the resulting defects affect properties, we have developed new ways to integrate dissimilar semiconductors for optoelectronics.

**Kunal Mukherjee** is an assistant professor in the Department of Materials Science and Engineering at Stanford University. His research focuses on compound semiconductor thin-film synthesis and defect science. He received a B.Eng. in Electrical Engineering from Nanyang Technological University, an M.S. from the National University of Singapore, and an M.Eng. and Ph.D. in Materials Science and Engineering from MIT. Before joining Stanford, he held postdoctoral appointments at IBM and MIT and served as an assistant professor in the Materials Department at UC Santa Barbara from 2016 to 2020. His work on epitaxy and crystal defects has been recognized with an NSF CAREER Award, the Corbett Prize at the International Conference on Defects in Semiconductors, the Young Scientist Award at the International Symposium on Compound Semiconductors, and the Young Investigator Award at the North American Molecular Beam Epitaxy Conference.

## Tuesday, Oct. 6 • 4 pm CT • Tech L211

*In person only; no Zoom*

*Questions? Contact allison.macknick@northwestern.edu*

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