Arend van der Zande
University of Illinois at Urbana-Champaign, Urbana, IL, USA

arendv@illinois.edu

Strain Resilient versus Strain Reconfigurable Systems in 2D Material Heterostructures

Understanding the mechanical deformability of nanomaterials is critical to realizing a host of next generation technologies like stretchable electronics, reconfigurable quantum states, three dimensional multifunctional surfaces, and nanoscale machines. Due to their unparalleled mechanical strength and stability, two-dimensional (2D) materials like graphene and MoS_2 represent the ultimate limit in size of both mechanical atomic membranes and molecular electronics. One of the most exciting research directions is on how to integrate the outstanding mechanical properties and electronic functionality of 2D materials together. In this presentation, we will: (1) Discuss strategies for designing strain, strain gradients and interfacial slip in 2D materials through nanoscale bends, microscale wrinkling, and deposited stressor layers; (2) Explore the interplay between interfacial friction and slip, mechanical deformability, material strain, and resulting optoelectronic properties; (3) Demonstrate 2D material based stretchable electronics and nanoelectromechanical systems which leverage the electromechanical coupling and interfacial structure to enhance reconfigurability. Taken together, these experiments show that interfacial slip strongly affects the mechanics and electronics of 2D material heterostructures and leads to membranes which are orders of magnitude more deformable than conventional 3D materials.