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Electromechanical systems enabled by interfacial slip 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 MoS2 represent the ultimate limit in size of both mechanical atomic membranes and molecular electronics. Moreover, many of the most interesting properties of 2D materials and new functionality arise from the van der Waals interfaces between layers and in engineering multilayer heterostructures. Open questions include how the interface affects the mechanical properties of 2D heterostructures and how to integrate the outstanding mechanical properties and electronic functionality of 2D materials together. In this presentation, we will examine the impact of the van der Waals interface on the mechanics of bending and crumpling of 2D atomic membranes, slip in nanoelectromechanical drumhead resonators, and optoelectronic devices from crumpled 2D heterostructures. Taken together, these experiments show that interfacial slip strongly affects the mechanics of 2D materials and heterostructures and leads to membranes which are orders of magnitude more deformable than conventional 3D materials