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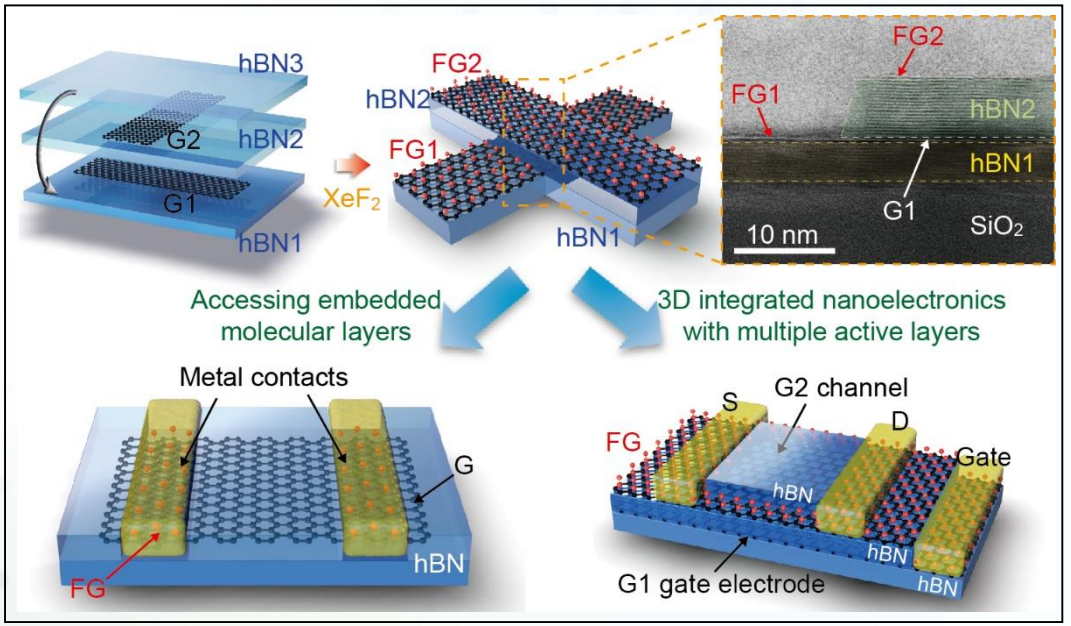
Atomically-precise graphene etch masks for 3D integrated systems from 2D material heterostructures

A. van der Zande, P. Huang, N. Mason, E. Ertekin
University of Illinois Urbana-Champaign

Atomically-precise fabrication methods are critical for the development of next-generation technologies which rely on nanomaterials. New methods are particularly needed in van der Waals (vdW) heterostructures where it is necessary to individually address each molecular layer to form devices with nanometer thicknesses.

The Illinois MRSEC has demonstrated a highly selective etching technique using graphene as a monolayer etch stop within vdW heterostructures. This technique is a versatile and simple nanofabrication process that bridges the challenging technological divide between atomic-precision and wafer scale uniformity. At the same time, it enables a method for accessing buried layers within a 2D heterostructure, thus allowing 3D-integrated nanoelectronic and nanomechanical devices with performance approaching theoretical limits.



(top) Schematic of the selective etching process and false-color cross-sectional STEM image of a 2D heterostructure showing atomic precision of the etched structure. (bottom) Demonstrated applications using this technique: Accessing buried electronic layers within a heterostructure to form low contact resistance and high mobility devices and a 3D integrated device with multiple active layers.

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