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An In-Plane Epitaxial Heterostructure of Two-Dimensional Crystals

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By adapting the concept of epitaxy to two-dimensional (2D) space, a single-atomic-layer, in-plane heterostructure of a prototypical material system, graphene and hexagonal boron nitride (h-BN), has been grown. It is shown by multiple complementary experimental techniques that monolayer crystalline h-BN grows from fresh edges of monolayer graphene with lattice coherence, forming an abrupt 1D interface. The challenges of obtaining truly 2D heterostructures with lattice coherence and sharp interface unassisted by templates in the third dimension will be discussed. Importantly, the h-BN lattice orientation is solely determined by the graphene, forgoing configurations favored by the supporting substrate, a polycrystalline Cu foil with an exclusively (100) surface. To illustrate this important feature of heteroepitaxy in 2D, this talk will briefly discuss the graphene/Cu(100) and h-BN/Cu(100) orientational relations when the two materials are grown alone on Cu foils. For a counterintuitive reason, when grown alone, h-BN strictly aligns to Cu(100) exhibiting four and only four symmetrically equivalent orientations, while graphene shows a wide spread of rotations. The energetically favored h-BN/Cu(100) orientational alignment is overridden when h-BN is grown as an "epistrip" templated by a graphene edge. This talk will allude to the interesting physics of the 1D boundary states that has been theoretically predicted, such as spin polarization. As an intermediate step towards establishing the long-predicted physical properties, the boundary states have been observed by atomic-resolution scanning tunneling microscopy and tunneling spectrum mapping, although the sought-after spin polarization is destroyed by the presence of the Cu substrate.

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