A closer look at graphene bandgap engineering

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After the initial excitement about graphene's high performant and scientifically rich electronic properties, one of the most obnoxious challenges have been to pattern graphene on a small scale. In theory, nanostructuring of graphene opens for the electronic and photonic properties to be "programmed" to match specific applications or to bring out entirely new physics. In practice, even low levels of edge disorder and contamination associated with even the best lithographic processes, strongly impair the electronic properties. I will discuss our progress in creating lithographic "nanoporous" graphene [1], where we combine encapsulation in hexagonal boron nitride (hBN), high-density lithography, and carefully tuned anisotropic etching process, to pattern graphene on the 10 nm scale, and still preserve the detailed magnetotransport signatures predicted by tight-binding calculations (Fig. 1). The surprising survival of the subtle moire-superlattice signatures associated with twisting of the crystalline interlayers opens for construction of circuits and components that exploit this emerging branch of solid-state physics. I will explain how anisotropic etching of hBN using SF_6, can be used for super-resolution nanolithography, enabling downsizing of features way below conventional lithography limits [2]. Recent nano-ARPES mapping of the bandstructure performed insitu on patterned, gatable devices, confirm that the electric behavior can indeed be explained by a antidot-lattice induced bandgap [3], as predicted 14 years ago [4].

References

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Figures

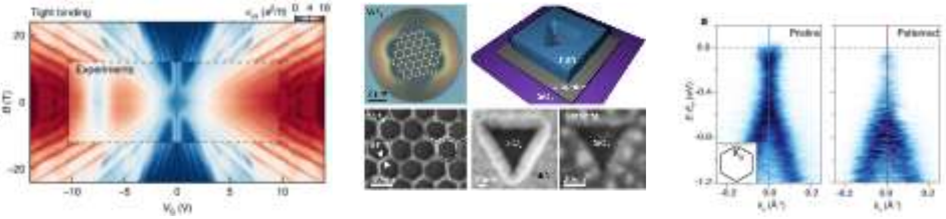

Fig. 1. (Left) Experimental vs theoretical magnetotransport of nanopatterned graphene. (Center) Ultradense patterning using anisotropic etching. (Right) Nano-ARPES of nanopatterned graphene.