MAR15-2014-020038

Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Formation and electronic properties of coherent in-plane 2D heterostructures[1]

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Two-dimensional (2D) interfaces between crystalline materials have been shown to generate unusual interfacial electronic states in complex oxides. Recently, a one-dimensional (1D) interface has been suggested in hexagonal boron nitride (hBN) and graphene planar heterostructures, where a polar-on-nonpolar 1D boundary is expected to possess peculiar electronic states associated with edge states of graphene and the polarity of hBN. Here, we report on the formation and electronic properties of such a 1D interface. By implementing the concept of epitaxy to 2D space, we grow monolayer hBN from fresh edges of monolayer graphene with lattice coherence, forming a 1D boundary [L. Liu et al., Science 343, 163 (2014)]. Scanning tunneling microscopy and spectroscopy measurements reveal an abrupt 1D zigzag oriented boundary, with boundary states about 0.6 eV below or above the Fermi level depending on the termination of the hBN at the boundary [J. Park et al., Nature Commun. 5, 5403 (2014)]. The boundary states are extended along the boundary, and exponentially decay into the bulk of graphene and hBN. The origin of boundary states and the effect of the polarity discontinuity at the interface will be discussed.

[1]This research was conducted at the Center for Nanophase Materials Sciences, which is sponsored at Oak Ridge National Laboratory by the Scientific User Facilities Division, Office of Basic Energy Sciences, U.S. Department of Energy.