Observation of Kagome phase in graphene

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Abstract

In condensed-matter systems, distinct topological phases are undoubtedly linked to exotic physical properties. As for graphene, varieties of the symmetry-broken phases have been predicted yet seldom realized in experiment [1,2,3]. Here we propose that, a strong electronic modulation can give rise to an unprecedented phase—Kagome phase—in graphene. The strong electronic modulation, namely Friedel oscillation on graphene can be realized on designer monolayer boron nitride/Cu(111) hetero-substrate and by ordered adatoms segregated from Cu substrate. We show that the Kagome phase is the dominated feature in STM imaging, which "lattices" are composed of charge density states centered on carbon bonds other than carbon atoms. We also show that the origin of Kagome phase on graphene—the ordering of sandwiched adatoms—may relate to the tuning effect of moiré pattern, more than merely interadatom interaction in theory. The finding provides an effective way of modifying the electronic properties of graphene and open the possibility of spin-frustration study in graphene.

References

[1] Abhay N. Pasupathy *etc.*, Nature Physics, 12 (2016) 950
[2] Hari C. Manoharan etc., Nature, 483 (2012) 306
[3] V.V. Cheianov *etc.*, Solid State communication, 149 (2009) 1499

Figures

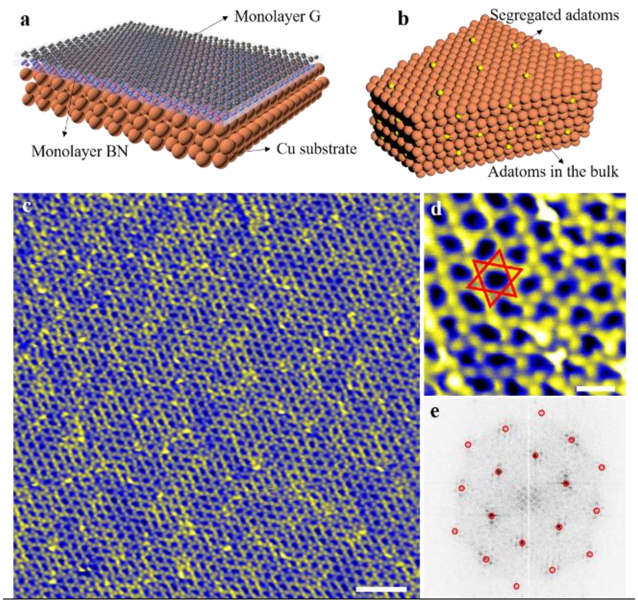

Figure 1: **a, b**, Schematic of Graphene/*h*-BN/Cu(111) heterostructures and adatom segregation process from Cu bulk. **c**, Large area STM image of Kagome phase. **d**, Zoom-in atomically resolved STM topography. **e**, Fourier transform (FT) of STM image in **c**. The scale bars in **c**, **d** are 2.5 nm, 0.5 nm, respectively.

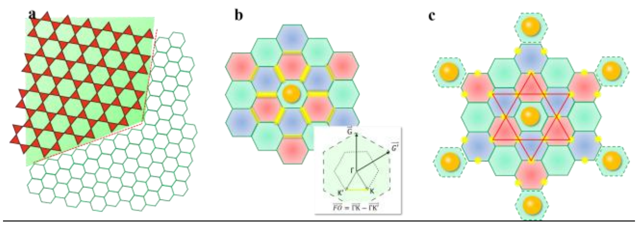

Figure 2: **a**, schematic illustration of the spatial relationship of Kagome phase and graphene lattice. **b**, Schematic of the origins of Friedel oscillation (FO) on graphene induced by adatoms (yellow balls) with a R3 periodicity. **c**, Illustration of Kagome "lattices" superimposed on the center of carbon bonds.