Massless Dirac Fermions Trapping in Quasi-1D and 0D *npn* Junctions of a Continuous Graphene Monolayer

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Abstract

Massless Dirac fermions in graphene provide unprecedented opportunities to realize the Klein paradox. In the seminal theoretical work [Katsnelson et al., Nat. Phys. 2 620 (2006)], it was predicted that the massless Dirac fermions can pass through potential barriers unimpededly at normal incidence. Such a result seems to preclude confinement of the massless Dirac fermions in graphene by using electric potential barriers.

Here, via STM measurements, we directly probe the quasi-bound states and image the wave functions of the confined massless Dirac fermions within the 1D npn junction, for the first time. All the experimental features are reproduced quite well in our theoretical calculations, as shown in Figure 1. Therefore, we demonstrate that the massless Dirac fermions can be locally confined in nanoscale regions of a continuous graphene monolayer by quasi-one dimensional npn junctions.

We further demonstrate that, through substrate engineering, GQDs with different geometrical shape and size, can be produced, and trap particular electronic states with energies and angular momentum. Via STM measurements. We directly obtained the confined electronic states and imaged the confined electrons inside the geometries, as shown in Figure 2.

References

[1] **Ke-Ke Bai,** Jia-Bin Qiao, Hua Jiang, Haiwen Liu, Lin He. Massless Dirac Fermions Trapping in a Quasi-1D npn junction of a continuous graphene manolayer. Submitted in Physical Review Letters.

Figures

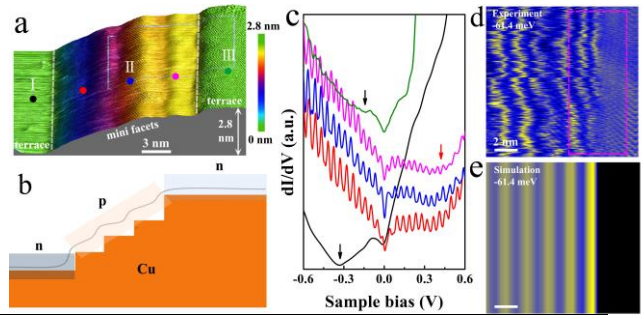

Figure 1: the structure and (experimental and theoretical) electronic properties of a quasi-1D npn junction, generated along the edges between two adjacent Cu terraces.

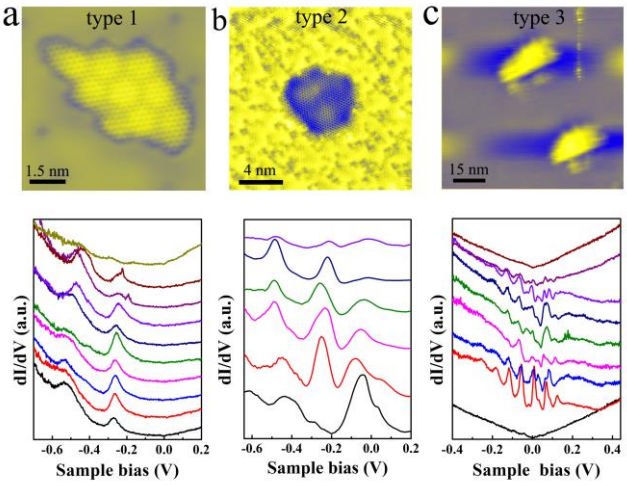

Figure 2: Typical structures and electronic properties of three types of GQDs of a continuous graphene monolayer, generated by Cu substrate engineering.