Charge and spin transport anisotropy in nanopatterned graphene

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Abstract

Anisotropic electronic transport is a possible route towards nanoscale circuitry design, particularly in two-dimensional materials. Proposals to introduce such a feature in patterned graphene have to date relied on large-scale structural inhomogeneities. Here we theoretically explore how a random, yet homogeneous, distribution of zigzag-edged triangular perforations (Fig. 1) can generate spatial anisotropies in both charge and spin transport. Anisotropic electronic transport is found to persist under considerable disordering of the perforation edges, suggesting its viability under realistic experimental conditions (Fig 2). Furthermore, controlling the relative orientation of perforations enables spin filtering of the transmitted electrons, resulting in a half-metallic anisotropic transport regime. Our findings point towards a co-integration of charge and spin control in a two-dimensional platform of relevance for nanocircuit design.

References

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Figures

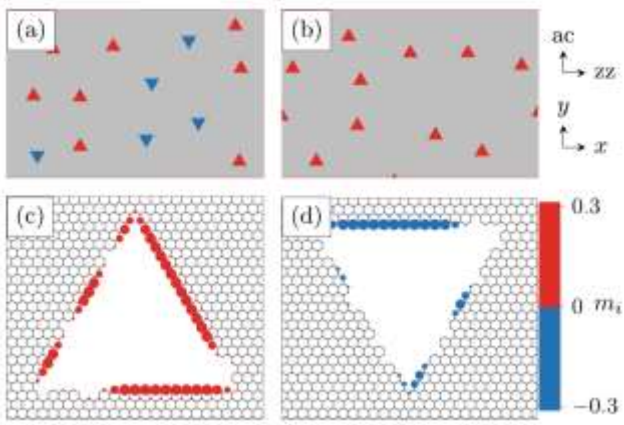

Figure 1: a) Randomly oriented and b) aligned distributions of zigzag edged triangular perforations. c) and d) show atomic structure and magnetic profile of individual edge-disordered perforations

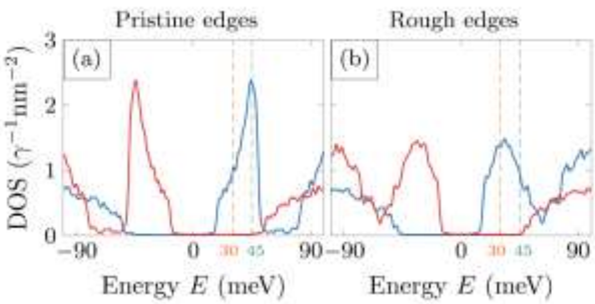

Figure 2: Density of states for spin up (red) and spin (down) electrons for an aligned distribution of triangular perforations (see Fig 1b). A robust spin-polarisation is seen near the Fermi energy (a) which persists under edge disorder (b).