Transport properties through a single grain boundary in graphene systems: strain effects versus lattice symmetry

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Abstract
As most materials available at macroscopic scale, graphene samples usually appear in a polycrystalline form and thus contain grain boundaries [1]. This kind of structural defects, on the one hand, strongly affects the intrinsic properties of graphene, on the other hand, offers the possibility of tailoring the electronic properties of differently oriented graphene domains in a graphene heterostructure [2]. In the present work [3], we investigate the electronic transport through a single graphene grain boundary (see Fig. 1) with the aim of clarifying the effects of uniaxial strain and roles of lattice symmetry of graphene domains surrounding the boundary. It is shown that in graphene systems where two domains exhibit different orientations, strain engineering can be used efficiently to open and modulate a finite transport gap (see Fig. 2). The gap is found to be strongly dependent on the strain magnitude, on the strain direction and on the lattice symmetry of graphene domains. Based on this, a large transort gap of a few hundreds meV can be achieved when a small strain of only a few percents is applied in an appropriate direction. By taking advantage of the large transport gap induced by strain, we suggest that this kind of graphene heterostructures could be very promising for applications as highly sensitive strain sensors, flexible transistors and devices exhibiting strong non-linear I-V characteristics. We additionally show that depending on the lattice symmetry of graphene domains, strain can have significant effects on the defect scattering in a specific class of graphene grain boundary systems. In particular, strain engineering can be used to restrain the detrimental impact of defects on the transport properties of polycrystalline graphene.

References
[1] P. Y. Huang *et al.*, Nature **469**, 389–392 (2011).
[2] A. W. Cummings *et al.*, Adv. Mater. **26**, 5079-5094 (2014).
[3] V. H. Nguyen *et al.*, arXiv:1601.06924

Figures

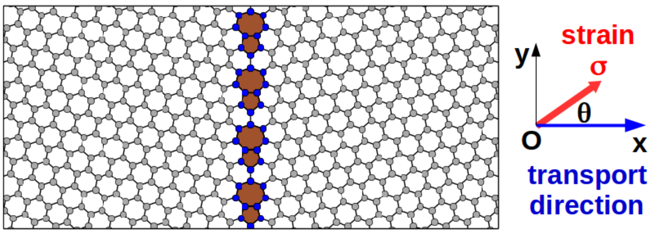

Figure 1. Example of a graphene grain boundary system studied in this work.

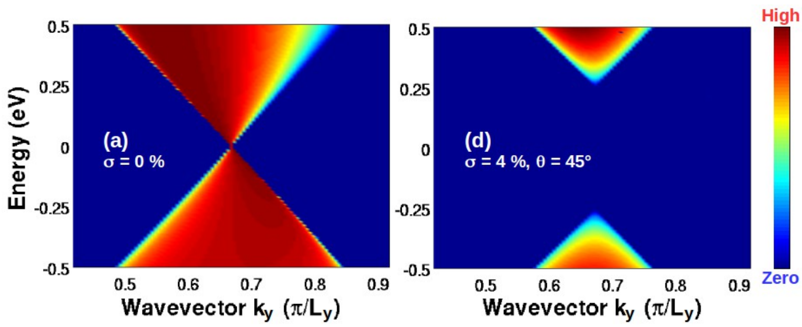

Figure 2. (E-k_y) maps of transmission probability through graphene grain boundary with and without strain.