Impact of vacancies on twisted bilayer graphene quantum point contacts

Pablo Moles Matías
Leonor Chico and Francisco Domínguez-Adame
Universidad Complutense de Madrid, Avenida Complutense s/n, 28040, Madrid, Spain
pmoles@ucm.es

Quantum point contacts (QPC), short one-dimensional conductors that can be electrostatically defined or etched in two-dimensional materials, are the center of attention for their prospective applications in spin, valley and charge nanodevices. Although fabrication by etching generally produces defects and roughness which hinder the properties of the pristine materia, recent cryo-etching techniques overcome these problems and have demonstrated the fabrication of low-defect graphene QPCs via etching processes, in which quantization of electron transport was experimentally observed. This is especially important for the study of twisted bilayer graphene QPCs, where the interplay of moiré and edge localization should be studied in systems with well-defined edges. In this work we provide a theoreticall background to those systems. We study the electronic transport properties of a twisted bilayer graphene QPC consisting of a bilayer flake contacted by two monolayer graphene nanoribbons which act as leads. Numerical simulations are carried out with the help of the package Kwant for quantum transport, using a tight-binding model. The conductance and the spatial distribution of electronic states in the QPC are computed. The conductance presents a strong dependence with the rotation angle between layers and is quantized for relatively large angles. Despite the progress on fabrication techniques, some defects or impurities might be present in experimental devices, so furhtermore we study the effect on the conduction caused by adding vacancy defects to the system.

References

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Figures

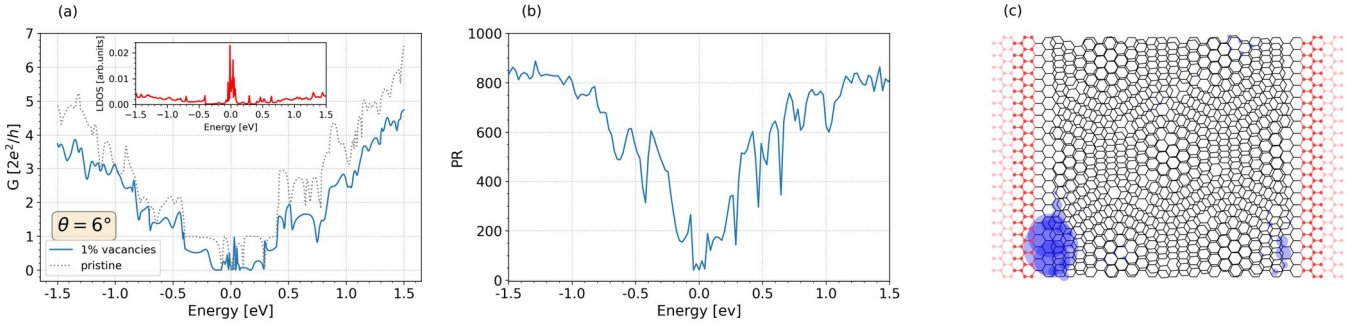

Figure 1: (a) Conductance of a pristine twisted bilayer QPC (grey dashed line) and conductance due to a vacancy distribution extended over the QPC (blue line) for a concentration value of 1%. The inset plots the LDOS summed over all atoms of the QPC (red line). (b) Participation Ratio of the system states. (c) LDOS at energy E=0. The radii of the circles are proportional to the LDOS value on each atom.