Long range effects on quantum conductance of screw-like doping in N doped-carbon nanotubes

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Abstract

Long-range electronic effects in doped 2D graphene have been highlighted on the STM images and on the density of states close to the Fermi level in ordered and disordered systems [1]. Here, the consequences of long-range interference effects on 1D carbon nanotubes are investigated. In that perspective, the quantum electronic transport properties of Nitrogen (N) doped carbon nanotubes are studied in the Landauer-Buttinger approach within the tight-binding approximation [2-5].

First, resonance states are shown to appear at given energies depending on the periodicity and on the number of periods, even for distant dopant. Two classes of universal transmission responses are observed depending on the periodicity. They are related to the appearance (or not) of an electronic gap for infinite systems around the defect band. More precisely, the quantum conductance drops to one quantum conductance plateau when the distance between the dopant is three times the period of a pristine armchair nanotube, demonstrating a standing waves behavior of the electronic states associated with the electron transport. For other periodicity, no conductance is observed at the energies of the electronic state localized on the defect.

Second, a screw configuration is considered for the position of the dopant, around the nanotube, i.e. the defects are regularly rotated from one period to the other. We found that the quantum conductance depends on the rotation angle between the defects and that, for given angles, screw-like configuration has no effect on the transport properties. Moreover, rotational disorder does not change the quantum conductance scheme within a few classes of screw angles.

References

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