Transport Properties Of Carbon Nanotubes Under High Magnetic Fields

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In spite of the plethora of studies dealing with the transport properties of carbon nanotubes (CNTs), the influence of the external magnetic field on the conductance of these systems has not been widely explored yet [1-4]. Recently, we have undertaken extensive experimental and theoretical studies to investigate the possibility of tuning the electrical conductance of CNTs with vertically applied high magnetic field. In a series of experiments the current-voltage characteristics have been measured under magnetic field of the strength up to several dozen Teslas. In this contribution, we focus on the theoretical studies that deepen understanding of the observed phenomena and facilitate the design of required functionalities.

In our theoretical research, we study the electronic structure of biased CNTs in magnetic field, and further calculate the effect of magnetic field on the electron transmission through various CNT based devices. We consider single-wall and multi-wall CNTs with different dimensions (diameter and length) and chirality, both pristine and defected (i.e., with pentagon-heptagon defects, or tubes collapsed or with various stages of deformation). In addition, we consider also the role of CNTs' functionalization (e.g., with nitric acid). Most of the studies have been performed for junctions consisting of a single CNT (single- or multi-wall). However, we also investigate junctions built out of two CNTs placed one above the other, but each attached only to one electrode, where the current conductance requires tunnelling of electrons between separate CNTs. The transport studies have been performed using TBtrans, the tight-binding code employing non-equilibrium Green's Function formalism. The external magnetic field was added to the tight-binding Hamiltonian by Peierls substitution in sisl python package.

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