Electronic Transport Properties of a Metal-Semiconductor Carbon Nanotube Heterojunction

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Abstract

Carbon nanotube heterostructures are currently at the forefront of nanotechnology research. Among the recent achievements in this field, one may mention the observation and subsequent theoretical characterization of two- [1,2], three- [3-7] and four-terminal [8] nanotube junctions. It has been suggested that these heterostructures can be used as possible nanoelectronics building blocks. Although three- and four-terminal junctions seem to be more promising in this regard, the two-terminal junction may have its own merits; namely, being rather simple, its production might be easier compared to the more intricate junctions. Moreover, an intrinsic "left-right" asymmetry that is usually present in two-terminal heterojunctions makes them suitable for possible rectifying applications without a need to external agents to achieve the required asymmetry [9].

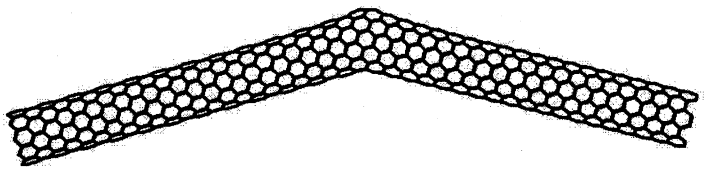

Fig. 1. The nanotube heterojunction resulting from the attachment of (10,0) and (6,6) nanotubes.

Here, we study the electronic transport, i.e., I-V, properties of a typical metal-semiconductor nanotube heterojunction, made up of a (10,0) and a (6,6) nanotube attached through a heptagon-pentagon defect. We use a four-orbital per atom tight-binding model, and calculate the conductance and I-V characteristics through the non-equilibrium Green's function approach and Landauer's formalism. The possibility of rectifying effect, the charge distribution under bias, and the effect of the bias potential drop across the junction is investigated.

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