Deformation and Electrical Properties of Carbon Nanotubes on Flat Surfaces with Different van der Waals Interactions

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Abstract
Electrostatic Coupling between two adjacent 2-Dimensional (2D) van der Waals (vdW) materials results with intriguing quantum phases and Moire patterns. Similar behaviour is also anticipated between 1D and 2D vdW materials [1]. In this study, the interaction between carbon nanotubes and different substrates is investigated using atomic-force microscopy, aligned growth, electrical measurements, and atomistic simulations. Our findings show that CNTs are attracted to substrates with identical or similar atomic structures more than to amorphous silica, resulting with higher binding energies and stronger elastic deformation of the CNTs (Figure 1). Evidences for Moire patterns between the two lattices were found, and modulation of the conductance with respect to the relative angle between the two lattices was observed. At low temperatures single electron transistors (SETs) are realised with plethora of Coulomb Blockade spectra (Figure 2). These results suggest that electronic devices based on CNTs and two-dimensional materials will operate differently than conventional CNT transistors and anticipate to have interesting quantum transport.

References

[1] Benedetta Flebus and Allan MacDonald, Physical Review Research, 2 (2020) 022041.

Figures

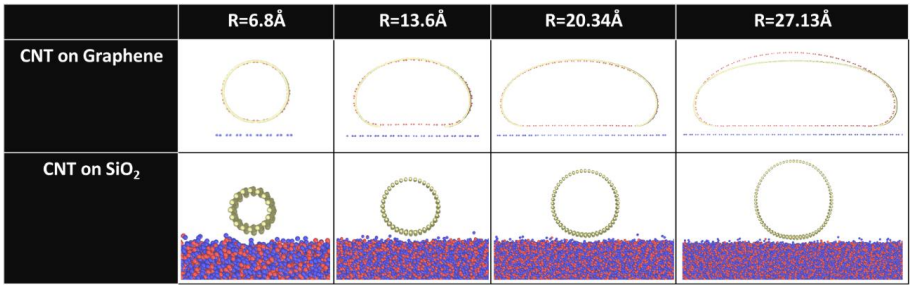

Figure 1: Molecular Dynamic simulations of CNTs on top of graphene and SiO_2 for different initial CNT radii.

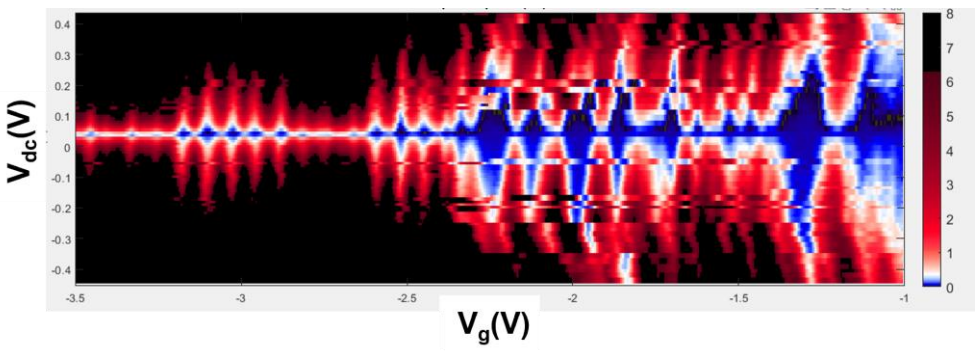

Figure 2: Coulomb Blockade Diamonds of hBN-CNT-hBN SET.