A CARBON NANOTUBE BASED NANORELAY

Magnus Jonsson,[a] Tomas Nord,[a] Susanne Viefers[a,b] and Jari Kinaret[a]

[a]Chalmers University of Technology and Göteborg University, Department of Applied Physics, SE-412 96 Göteborg Sweden

[b]University of Oslo, Department of Physics, Postboks 1048 - Blindern N-0316 Oslo Norway

We perform a theoretical investigation of the operational characteristics of a nanorelay based on a carbon nanotube. A conducting multi walled nantube (MWNT) is placed on a terrace in a silicon dioxide substrate connected to a source electrode. Two additional electrodes (gate and drain) are placed on the substrate below the terrace (Figure 1). By applying a voltage between the tube and gate and/or drain electrodes, an excess charge is induced in the nanotube and hence a capacitive force acts to bend the tube towards the drain electrode. If the deflection is large enough a tunnel current can flow from the tube to the drain electrode. We model the mechanical properties of the nanotube by classical continuum theory and use experimentally measured values values for the Young's modulus. The charge transport between the tube and the drain electrode is treated using the orthodox theory of Coulomb blockade.

The system acts as three-terminal switch that operates in the GHz regime and has been studied by Kinaret *et al.*[1]. A related two-terminal structure has been studied by Dequesnes *et al.*[2]. Due to the exponential dependence of the tunneling conductance on the distance there is a sharp transition between the conducting and the non-conducting states. Surface phenomena are important for the operational characteristics and in this work we have refined our previous treatment of short range forces such as the van der Waals and adhesion forces. The short range forces influence the geometry that is optimal for particular applications.

In this work we also analyze the application of the nanorelay as a memory element taking into account the effects of the surface forces. Other possible applications include logic devices, pulse generators and amplifiers.

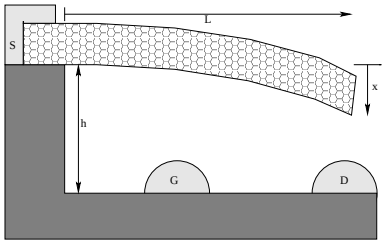

Figure 1

Schematic picture of the model system. A conducting MWNT is suspended over a terrace in a silicon dioxide surface. Typically the terrace height $h \approx 5nm$ and tube length $L \approx 50nm$.

REFERENCES

1. J.M. Kinaret, T. Nord and S. Viefers, arXiv:cond-mat/0208427 (2002)

2. M. Dequesnes, S.V. Rotkin and N.R. Aluru, Nanotechnology **13**, 129 (2002)