Numerical simulation of field effect transistors on nanotubes

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Abstract – This paper presents a theoretical investigation of transistor on nanotubes. The model considers the electron transport in nanotube. The current–voltage characteristics of carbon nanotubes transistor were investigated.

Keywords – carbon nanotube, field effect transistor, simulation of electron transport.

I. INTRODUCTION

The physical restrictions of scaling metal oxide semiconductor field effect transistors (MOSFET) are becoming more prevalent. Completely disruptive technologies are being researched and among them carbon nanotubes offer a technology with a unique solution to scaling transistors and interconnects and with the possibility of integration into the well established current silicon technology in the near future. Since the discovery of carbon nanotubes in 1991, by Sumio Lijima, their many extraordinary properties and applications have been researched closely. Carbon nanotubes (CNTs) can grow up to millimeters in length, however, their diameters are around 1 nm to 40 nm. These long thin nanotubes can withstand incredibly high current rates and can be used as both metal wires and channels of field effect transistors (FET). Due to these properties CNTs may be used to creation of new electronic nano components.

II. MAIN PART

The first CNT-FETs were reported in 1998 by Dekker’s group [1] and Martel et al. [2]. Such devices were fabricated using carbon nanotubes on top of SiO₂ and a Si-substrate that worked as a backgate, platinum (Pt) electrodes were used for the drain and the source contacts. The carbon nanotubes were produced by laser ablation synthesis and dispersed randomly on the SiO₂. This method showed poor characteristics since it was based on an undefined number of carbon nanotubes being bridged between the electrodes. Consequently, the use of chemical vapor deposition of methane on patterned substrate allowed the growth of carbon nanotubes being grown only in specific metallic catalyst islands . Early CNT-FETs were fabricated on oxidized Si substrates, the gate coupling was very poor due to the thick SiO₂ layer and back gate geometry. The major improvement was observed after the implementation of CNT-FETs using top-gate geometry.

III. CONCLUSION

A close agreement is obtained between the analytical models and the experimental observations in linear and saturation regions. Some disagreement is noted beyond Vₜₕ above 1 V. CNT-FETs model can be improved by the account dispersion of electron and contact effects.

REFERENCES