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Investigation of the performance and characteristics of linear doped Tunneling carbon nanotube field effect transistor

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ABSTRACT

A tunneling carbon nanotube field effect transistor with linear doped (LD-T-CNTFET) is presented for investigating band to band tunneling and improving the device characteristics with a non-equilibrium Green's function (NEGF) method. The LD-T-CNTFET structure includes two linear doped regions between the intrinsic channel and the highly doped source and drain regions which are called the linear doped drain and source T-CNTFET. Simulations have shown that LD-T-CNTFET characteristics are attributed to the linear doped region length. In comparison with a T-CNTFET, an LD-T-CNTFET with linear doped drain and source regions has shown a smaller off current (IOFF), a smaller sub-threshold swing, a lower on-current and tunneling current.

Keywords: Band to band tunneling (BTBT), Tunneling carbon nanotube field effect transistor (T-CNTFET), linear doped drain and source (LD), non-equilibrium Green's function (NEGF).

1. INTRODUCTION

Silicon based technology will reveal its limitations by 2020, when the channel length of MOSFET is less than 10nm [6]. As integrated circuit densities continue to increase, several emerging devices have been studied to find a suitable replace for silicon [2]. Carrying high current, ballistic transport, mechanical stability and dynamic load are made of carbon nanotubes as a suitable material to replace silicon as the channel field effect transistors [5]. The structural and electrostatic features of these nanotubes make them interesting for the future integrated circuit applications [2]. An important challenge for CNTFET study is to develop high performance transistors that operate at significant lower voltages. To maintain currents high, at lower voltages, it is likely that devices will need to operate with the sub-threshold swing below the conventional MOSFET limit of 60 mV/Decade _at room temperature_. Band-to-band tunneling _BTBT_ transport in devices has been suggested and illustrated as a means to produce low-voltage transistors. The BTBT FET device concept is currently being prospected in many material systems including those based on carbon nanotubes _CNTs_ and silicon. CNTs are particularly promising for such devices because their small effective masses and direct band-gap promote band to band tunneling [2]. Today, both p- and n-type CNTFETs have been fabricated. Experiment with quasi-planar gate geometries has demonstrated near-ballistic transport in p-type CNTFETs, and on-currents that exceed those of silicon-based transistors [7]. In order to enhance properties, Reza Yousefi and *et al* investigated LD-CNTFET and compared it with CNTFET in [3]. They found that LD region at source and drain sides lead to reduction of band to band tunneling at CNTFET structure, but it causes to improve CNTFET characteristics. In this paper, by using linear doped regions between the intrinsic channel and