Circuit level modeling of electrically doped adenine–thymine nanotube based field effect transistor

ABSTRACT

We investigate the gate-controlled, electrically doped tunnelling current in Adenine-Thymine heterojunction nanotube-based Field Effect Transistor (FET). This analytical model FET is designed by Density Functional Theory (DFT) and Non-Equilibrium Green's Function (NEGF) based First principle formalisms. It is demonstrated that Band to Band Tunnelling (BTBT) is possible in relaxed Adenine-Thymine heterostructure nanotube. The evaluation of BTBT tunnelling probability to estimate tunnelling current for only ±0.01V applied bias voltage is calculated using Wentzel-Kramers-Brillouin approximation. Electrical doping is introduced to eliminate the probability of fault generation. By keen observation on the shift of energy levels in the band structure, the availability of high transmission co-efficient peaks and current-voltage response we demonstrate the Schottky barrier nature for this geometrically pre-optimized bio-molecular FET. The doping concentration is varied from 0.0001V to 0.1V to achieve a substantially large amount of tunnelling current when the electronic temperature is kept at 300K. The E-k diagram or complex band structure of this heterostructure nanotube ensures its in-direct semi-conducting nature. This is a first attempt to present a circuit-level demonstration using this Adenine-Thymine nanotube-based bio-molecular FET and validate the obtained results with the existing approaches.

Keyword: Adenine-thymine; DFT; Nanotube; NEGF; TFET