Electrostatic characteristics of carbon nanotube array field effect transistors

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Carbon nanotube (CNT) field-effect transistors (FETs) with promising nanoscale device characteristics have recently been explored [1]. For ultrasmall nanoscale FETs, CNT FETs have provided fascinating characteristics by making a comparison between silicon-based metal-oxide-semiconductor FETs (MOSFETs) [1]. Arrays of CNT have been considered as a candidate to improve the electrical characteristics and physical properties (e.g., driving capability) of CNT FETs. For a CNT array, the screening of the charge induced by CNTs significantly affects the structure's electrostatic characteristics, such as capacitance, in particular when many CNTs are in close proximity [1,2]. In this paper, we simulate the gate capacitance for a CNT array with three different gate electrode structures: (1) top gate, (2) wrap around gate, (3) and bottom gate CNT structures. Taking the structure's radius and gate length of CNT FET into consideration, the three-dimensional potential distribution and corresponding gate capacitance are calculated using adaptive finite volume method. It is found that there is 20% difference in calculating capacitance between 2D and 3D modeling and simulation. Results of the 3D electrostatic simulations can also be applied to estimate the magnitude of on-current of CNT FETs.

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