Quantum drift-diffusion models for dual-gate field-effect transistors based on mono- and bilayer graphene

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Abstract: At present, a great deal of interest is observed in devices based on two-dimentional (2D) materials, especially graphene, in the field of micro- and nanoelectronics. Graphene has robust hoheycomb lattice structure and unique properties such as ambipolarity, high carrier mobility, high conductivity. Nevertheless the properties of mono- and bilayer graphene are different. A significant difference in electrical characteristics of field-effect transistors (FETs) based on mono- and bilayer graphene was shown in few experimental works [1-3]. Note, that FET on bilayer graphene has demonstrated improved characteristics in comparison to FET on monolayer graphene [1,4,5]. Therefore a necessity to create models specifically for FETs on bilayer graphene appears. A tunable band gap is observed in the FET, when a perpendicular electrical field is applied to the bilayer graphene channel [6]. In the paper a quantum drift-diffusion model of FETs based on

bilayer graphene is proposed. The model is a combination of electrical and physical models [7]. The mechanism of carrier transport along the bilayer graphene channel is considered. The electrostatic potential of the transistor channel is defined according to the band gap. Simulation of graphene dual-gate FET with channel length 4 μm is performed using the proposed model. Calculation of electrostatic potential of the investigated device structure was carried out. A good agreement with experimental data has been obtained for output characteristics of FETs based on monolayer graphene [8] using the developed model for this case. Different design parameters of FETs such as channel length, channel width, thickness of top- and back-gate dielectrics are used in the models. The proposed models of different FETs were included in the nanoelectronic devices simulation system NANODEV [9] developed at the BSUIR since 1995.

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