ANALYTIC MODEL OF QUANTUM ELECTROSTATIC POTENTIAL IN DOUBLE-GATE MOSFETs

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Double-gate (DG) silicon-on-insulator (SOI) MOSFETs (Fig. 1) with undoped channels is one of the most promising structures for scaling CMOS devices down to nanometer sizes [1]. Among the advantages of DG MOSFET can be distinguished the reduction of the OFF current, a better control of short channel effects, making unnecessary the conventional use of high channel doping densities and gradients, and the undoped channel eliminates intrinsic parameter fluctuations and minimizes impurity scattering.

MOSFET compact modelling for circuit simulation applications requires accurate formulations which are at the same time computationally efficient [2]. Some models that have been proposed for these devices do not take into account quantum effects and lack computational efficiency since they rely on numerical iteration to solve the fundamental equations [3-6]. In Ref. [7] Ge et. al proposed a compact quantum-effect model for DG-MOSFETs using a variational approach which is a good model for the volume inversion description but not for the electrostatic potential of Si-film larger than 5 nm and gate voltages above subthreshold region.

In this work we present an analytic model of the quantum electrostatic potential for DG-MOSFET structure. We extend a previous physics based analytic solution for the electrostatic potential of undoped (or lightly doped) DG-MOSFET [3] by incorporating a minimal number of parameters and without using numerical iterations. We obtain excellent results compared with results obtained from self-consistent numerical solutions from Poisson and Schrödinger equations (Figs. 2,3).

References:

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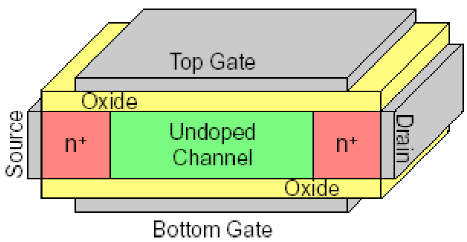

Figure 1. Schematic diagram of a DG-MOSFET

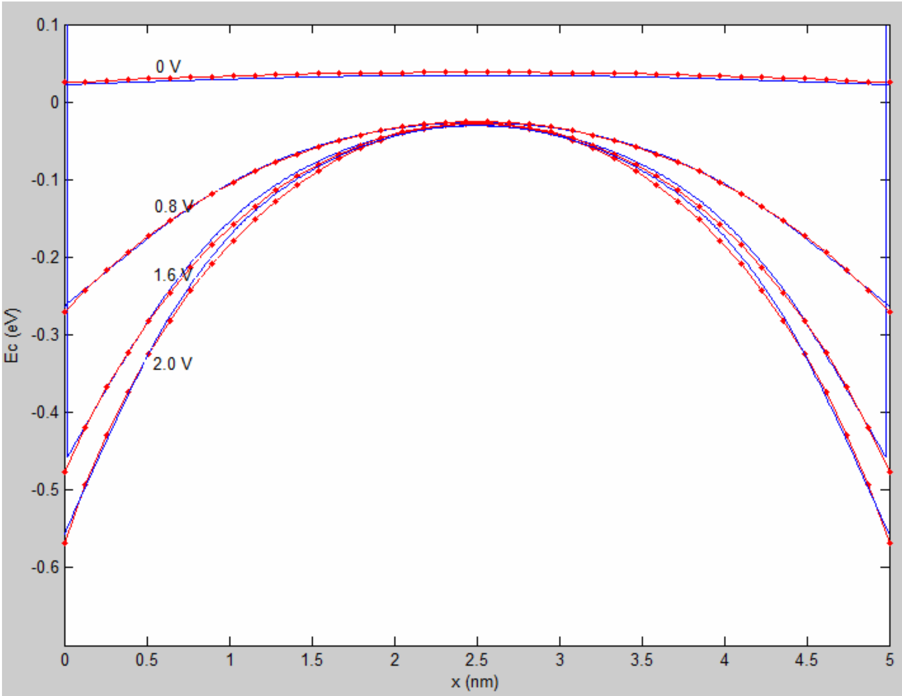

Figure 2. Conduction band profile in a 5 nm silicon film for different applied gate voltages. The continuous lines correspond to self-consistent Poisson-Schrodinger solutions (SHRED) and the dotted lines are derived from our model.

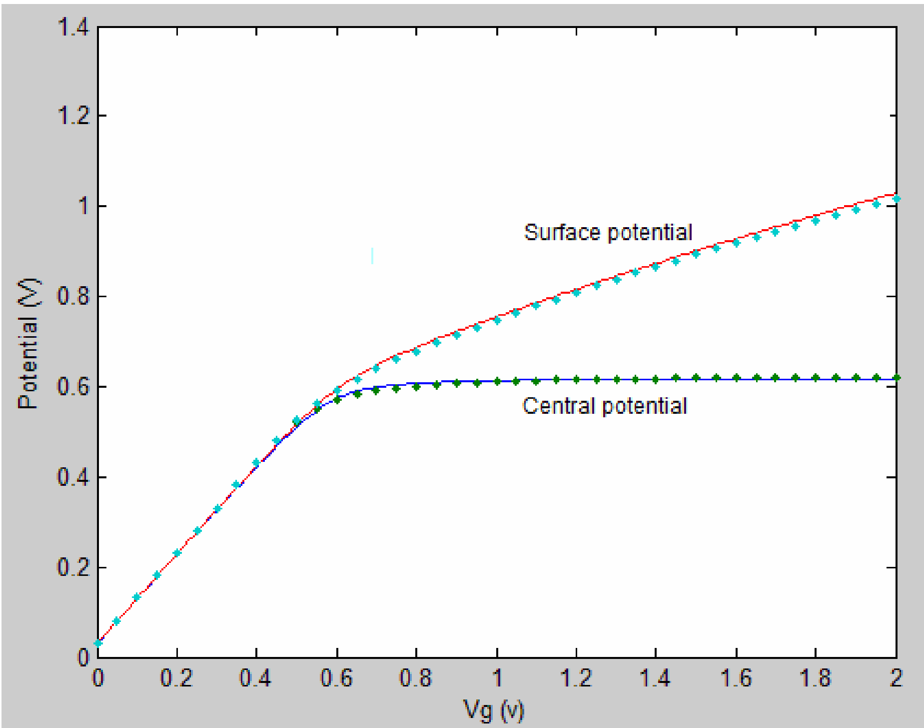

Figure 3. Surface and central potentials as a function of gate voltage. The continuous lines are self-consistent Poisson-Schrodinger solutions (SHRED) and the points are derived from our model.