Exercise: Basic Operation of SOI Device

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In this exercise we examine basic operation of an n-channel SOI device that the student has to determine whether it is a fully-depleted or partially-depleted device based on the results obtained. The starting geometry of the device is: $N_S=N_D=10^{20}$ cm^{-3}, $N_{body} = 10^{10}$ cm^{-3}, channel length is 50 nm, oxide thickness is 2 nm, body thickness is 15 nm, BOX thickness is 100 nm and substrate thickness is 68 nm. The gate is made of aluminum. For the transfer characteristics calculation use $V_{Gmin}=0$ and $V_{Gmax}=1.5$ V and $V_{Dmin}=0.05$ V and $V_{Dmax}=1.5$ V. For the output characteristics, to get stable convergence use: $V_{Dmin}=0$ V, V_{Dmax} = 1.5 V (40 bias points) and $V_{Gmin}=0$ V and V_{Gmax} = 1.5 V (6 bias points). Investigate the influence on the transfer and output characteristics of this device due to the:

1. Variation of the thickness of the substrate layer (compare the results of your simulations with 68 nm thick and 2 nm thick substrate.

2. Variation in the body thickness. Use body thicknesses of 15, 25, 35, 50, 100 and 200 nm. For all cases assume that the BOX layer thickness is 100 nm.

3. Variation in the BOX layer thickness. Use body thickness of 15 nm and vary the BOX thickness (50 nm, 100 nm, 200 nm and 300 nm).

4. In cases 1-3 it is assumed that impact ionization is not included in the model. For the device from case 1 with 68 nm thick substrate include the IMPACT option. Make sure to also use the BIPOLAR option, otherwise you will get physically incorrect results.

Comment on all the results obtained. Make sure to include concentration dependent mobility model, field-dependent mobility model and interface-roughness scattering via the mobility dependence of the perpendicular electric field.