Homework #13
Computational Microelectronics

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Due on December 10, 2018

1 Step 1: Non-linear Poisson equation

To implement the non-linear Poisson equation in 2D, we go back to the Poisson equation given by

$$\nabla \cdot [\epsilon(x)\nabla\phi(x)] = q(N_{acc}(x) + N_i \exp[\phi(x)/V_T]\,. \tag{1}$$

The derivation is similar to the case of the Laplace equation, in the lecture 13. In case of the Laplace equation, we assumed that the spacing value is same in the both directions. However, as a normal desktop does not have an enough memory to solve the equation with spacing 0.1 nm at each direction, we should set the spacing value at x and y differently. We set the spacing value at the x-direction to 1 nm. With different spacing values, the rate $r = dx/dz$ is applied to Jacobian and residue terms concerned with the y-direction.

Fig. 1, 2, and 3 show the potential ϕ and Fig. 4 displays the electron density at different V_g values. The potential at highly dopped region remains almost constant as V_g increases, while the potential at low dopped region increases very fast. As a result, the electron density at the low dopped region increases as V_g increases.

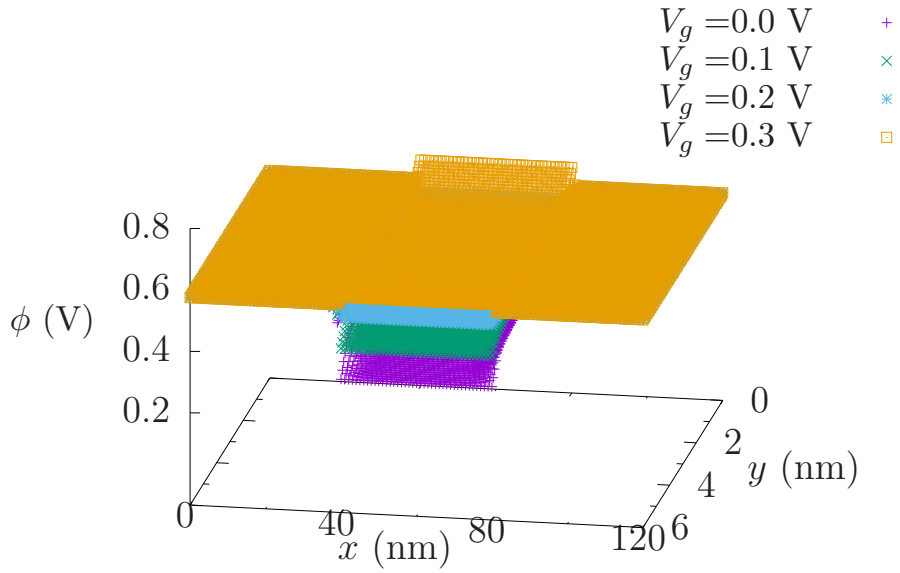

Figure 1: The potential at $V_g = 0, 0.1, 0.2, and 0.3$ V.

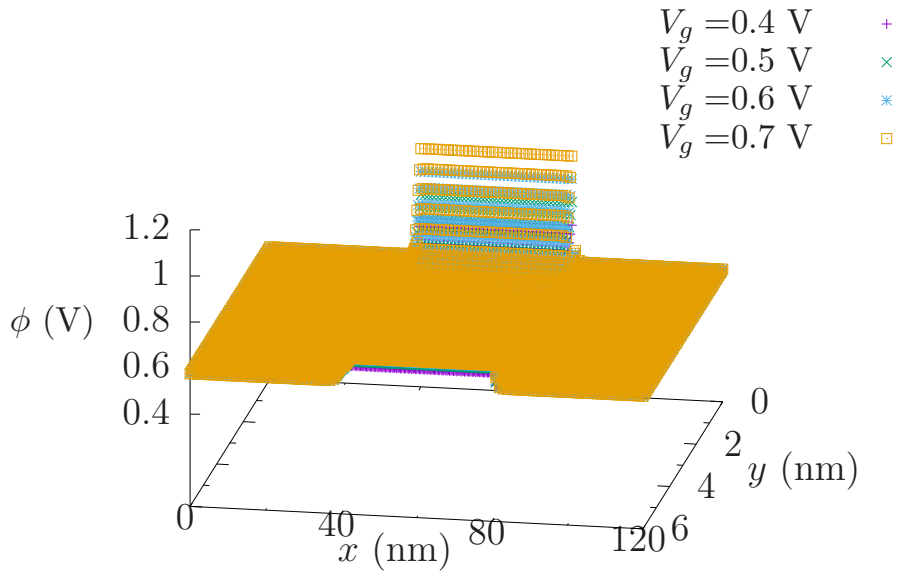

Figure 2: The potential at $V_g = 0.4, 0.5, 0.6, and 0.7$ V.

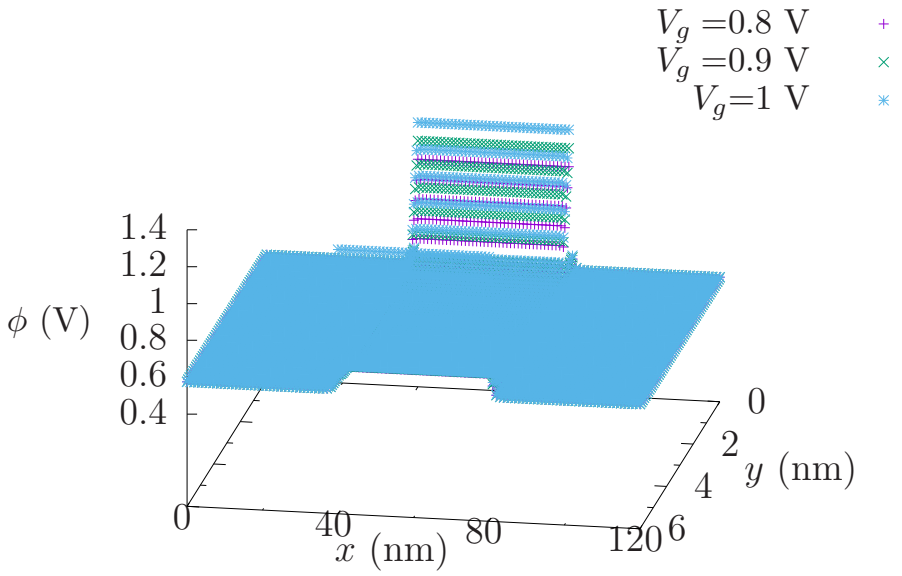

Figure 3: The potential at $V_g = 0.8, 0.9, and 1.0$ V.

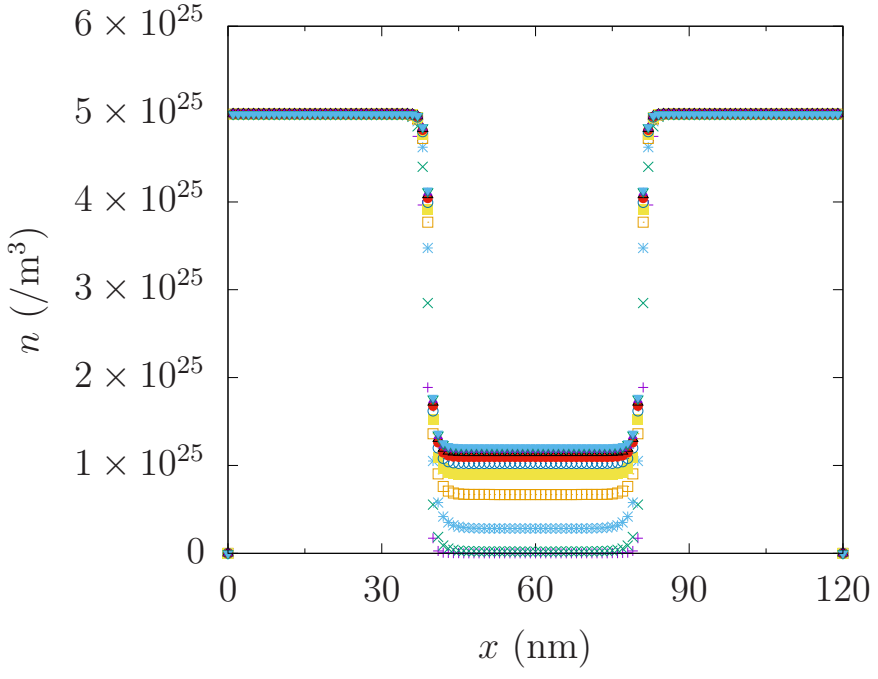

Figure 4: The electron density at the middle point in the z-direction. ($3nm$ height)