

Homework #2

Poisson's equation simulation

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1. Si - SiO₂ structure.

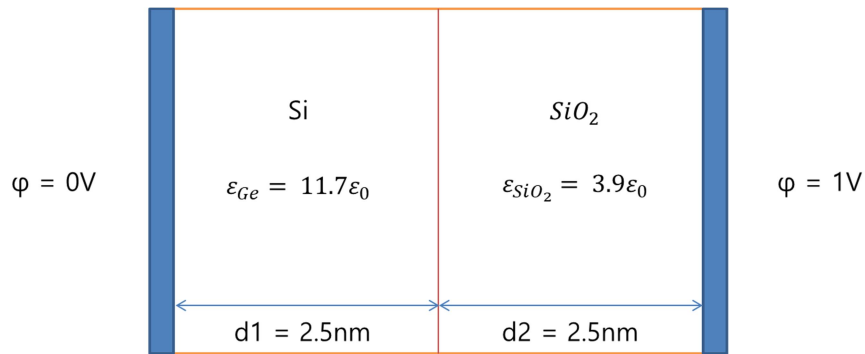


Figure 1. Structure of Si - SiO₂

The characteristics of the structure are shown in the following table.

Layer	Silicon	Silicon dioxide
Thickness (m)	2.5×10^{-9}	2.5×10^{-9}
Relative permittivity	11.7	3.9
Capacitance per area (F/cm ²)	4.144×10^{-6}	1.381×10^{-6}

Table 1. The characteristics of Si - SiO₂ structure.

The analytic solution is derived as the following equation.

$$\varphi_1(x) = \frac{2\varepsilon_2}{a(\varepsilon_1 + \varepsilon_2)}x, \quad \varphi_2(x) = \frac{2\varepsilon_1}{a(\varepsilon_1 + \varepsilon_2)}(x - a) + 1 \quad [2], [3]$$

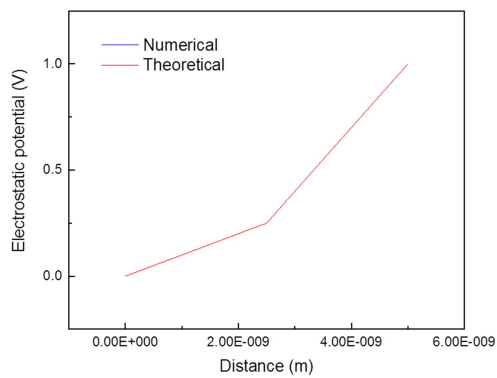


Figure 2. Electrostatic potential of Si - SiO₂ (V)

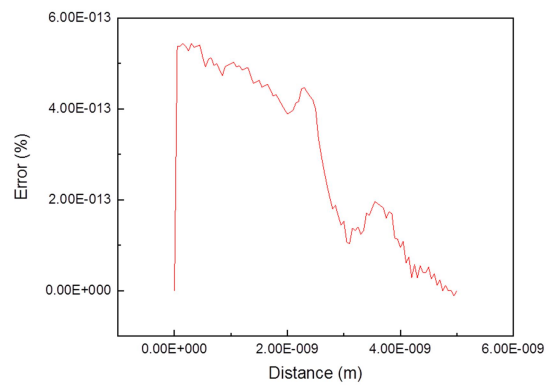


Figure 3. Error of Figure 2 (%)

2. Ge - SiO₂ structure.

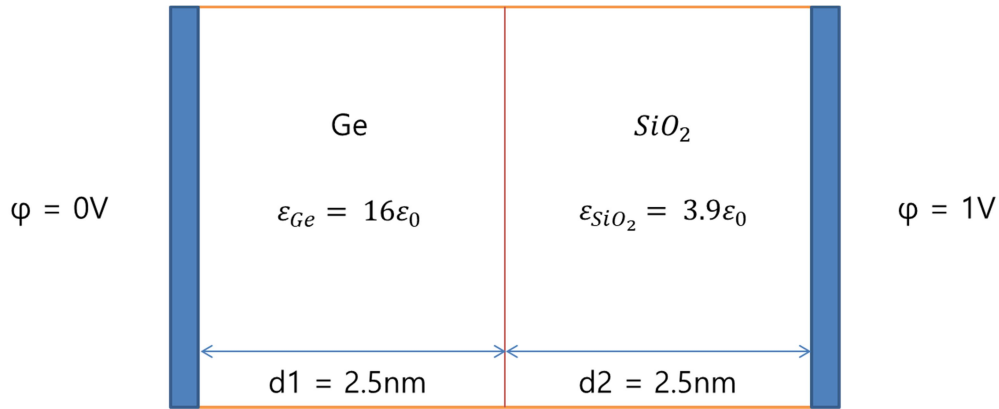


Figure 4. Structure of Ge - SiO₂

The characteristics of the structure are shown in the following table.

Layer	Germanium	Silicon dioxide
Thickness (m)	2.5×10^{-9}	2.5×10^{-9}
Relative permittivity	16	3.9
Capacitance per Area (F/cm ²)	5.67×10^{-6}	1.38×10^{-6}

Table 2. The characteristics of Ge - SiO₂ structure.

Also, we can use analytic solution [2], [3].

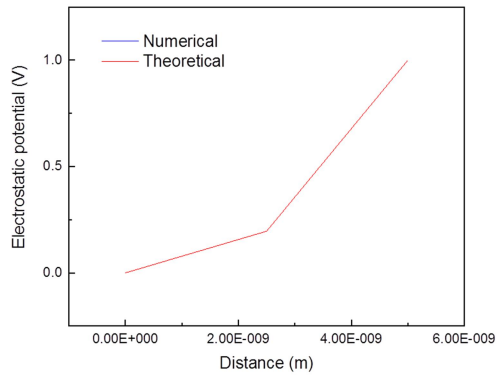


Figure 5. Electrostatic potential of Ge - SiO₂ (V)

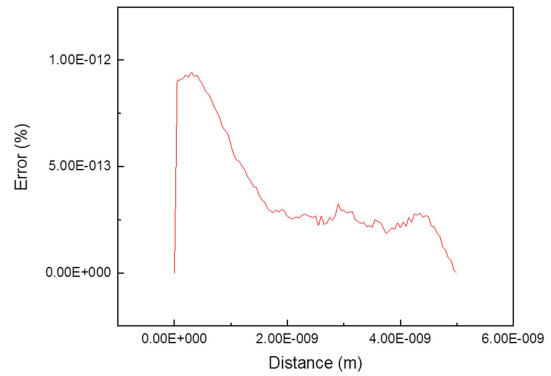


Figure 6. Error of Figure 5 (%)

In two simulations for both structures, the error is sufficiently small that a reliable value can be obtained.