HW #5

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Newton-Raphson method

1. Environment setting

The equation for this Newton-Raphson method test is below.

$$n_i e^{-\frac{\phi}{V_T}} - n_i e^{\frac{\phi}{V_T}} = 0 \quad [1]$$

Where N^+ is doping density, n_i is intrinsic carrier density, ϕ is electrostatic potential, and V_T is thermal voltage. Also the analytic solution of the equation is below.

$$\phi = -V_T \ln\left(\frac{N^+}{2n_i} + \sqrt{\left(\frac{N^+}{2n_i}\right)^2 + 1}\right) \quad [2]$$

has same quantities with [1].

I set N^+ is from $10^{10}\mathrm{cm}^{-3}$(positive/negative) to $10^{18}\mathrm{cm}^{-3}$(positive/negative), $n_i = 10^{10}\,\mathrm{cm}^{-3}$, $V_T = 0.026\mathrm{V}$, accuracy is 10^{-13}(It means $d\phi/\phi < 10^{-13}$), and start point of electrostatic potential is (positive:1V / negative:-1V).

2. Result

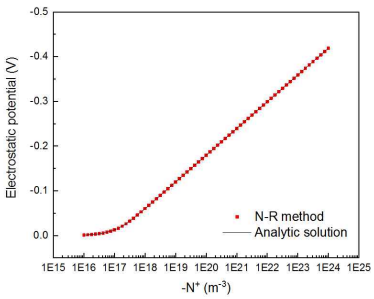

Fig 1. Electrostatic potential When N^+ is negative.

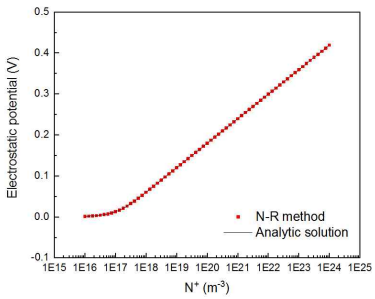

Fig 2. Electrostatic potential When N^+ is positive.

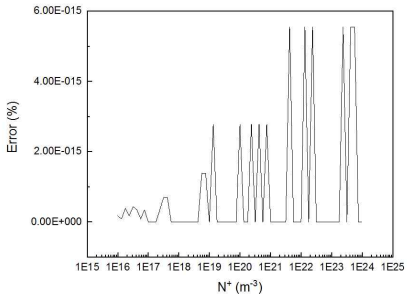

Fig 3. Error

The result said that the error is not larger then 10^{-13}. Therefore N-R method can be used for this function.