

國立中山大學 107 學年度碩士暨碩士專班招生考試試題

科目名稱：半導體概論【電機系碩士班甲組】

題號：431012

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）

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Dielectric constant: Si = 11.9 ; SiO₂ = 3.9. Bandgap: Si = 1.12 eV ; GaAs = 1.42 eV.

1. A silicon sample has a doping profile with donors $N_D = N_0 \exp(-mx)$. If $N_D \gg n_i$, find the expression for the built-in electric field at equilibrium. (20%)
2. A Si p-n junction has same doping concentration $2 \times 10^{16} \text{ cm}^{-3}$ in each side. The peak electric field in the junction at breakdown is $2 \times 10^5 \text{ V/cm}$. Calculate the reverse breakdown voltage of this junction at 300K. (20%)
3. Calculate the oxide capacitance, the flatband capacitance, and the high frequency capacitance in inversion of a silicon MOS capacitor with a substrate doping $N_A = 2 \times 10^{17} \text{ cm}^{-3}$, a 25 nm thick silicon dioxide and an aluminum gate ($\phi_M = 4.1 \text{ V}$). (20%)
4. For heterojunctions in the GaAs-AlGaAs system, the direct bandgap difference is accommodated approximately $\frac{2}{3}$ in the conduction band and $\frac{1}{3}$ in the valence band. The bandgap of AlGaAs is 1.85 eV if Al composition is 0.3. Draw the band diagrams of two heterojunctions:
(a) N^+ -Al_{0.3}Ga_{0.7}As on n-GaAs (b) P^+ -Al_{0.3}Ga_{0.7}As on n-GaAs (20%)
5. In a metal-Si Schottky barrier contact, the barrier height is 0.85 eV and the effective Richardson constant is $110 \text{ A/K}^2\text{-cm}^2$. Calculate the ratio of the injected hole current to the electron current at 300K. $D_p = 12 \text{ cm}^2/\text{s}$, $\tau_p = 5 \times 10^{-7} \text{ s}$, and $N_D = 2 \times 10^{16} \text{ cm}^{-3}$. (20%)