

大葉大學 九十四 學年度 研究所博士班 招生考試試題紙

系 所 別	組 別	考 試 科 目 (中文名稱)	考 試 日 期	節 次	備 註
電機工程學系	甲	固態電子學	6月20日	第 1 節	共 1 頁

註：考生可否攜帶計算機或其他資料作答，請在備註欄註明（如未註明，一律不准攜帶）

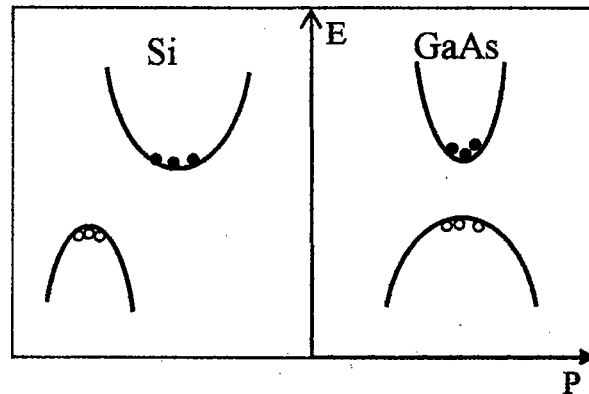
1. Figure 1 shows the approximate band structure for Si and GaAs.

(a) (10分) They are direct semiconductor or indirect semiconductor?

(b) (5分) For the effective mass of electron m_n in the conduction band, which one is larger?

(c) (5分) In the valence band, which hole effective mass m_p is larger?

Figure 1



2. The Si is doped by 10^{16} B atoms per cm^3 , and it is known that the intrinsic carrier density n_i of Si is around 10^{10} cm^{-3} , energy gap 1.12 eV, at 300 K.

(a) (10分) Calculate the carrier densities of electron (n) and hole (p) at 300 K.

(b) (10分) IF the effective density of states in valence band for Si, N_v , is 10^{19} cm^{-3} , calculate the energy (in unit of eV) between Fermi level and the top of valence band, $E_F - E_v$, at 300 K. (Boltzmann's constant: $8.625 \times 10^{-5} \text{ eV/K}$, $\ln 10 \approx 2.3$)

(c) (10分) Calculate the energy shift (in unit of eV) between the intrinsic Fermi level E_i and the Fermi level E_F , $E_i - E_F$, at 300 K.

(d) (10分) If the mobility of Si is $1000 \text{ cm}^2/\text{Vs}$, estimate the resistivity of Si at 300 K. (charge on electron: $1.6 \times 10^{-19} \text{ C}$)

3. Combine a Si film doped by 10^{17} As atoms per cm^3 with that previously described in Problem 2 to perform a $p-n$ diode.

(a) (10分) Calculate the built-in potential V_{bi} in it at 300 K in a thermal-equilibrium state.

(b) (10分) This diode is applied to a solar cell, and illuminated by a light with wavelength λ nm. What is the maximum value of λ needed to induce the photo-electric current? (Planck's constant: $6.63 \times 10^{-34} \text{ Js}$, light speed: $3 \times 10^8 \text{ m/s}$)

4. (10分) Plot a diagram to describe the Zener diode V-I (voltage - current) characteristics with the Zener current I_Z and Zener voltage V_Z clearly pointed.

5. (10分) Explain the origins of (a) light-emitting diode and (b) Laser diode, and describe the difference between them. (You can draw pictures and answer this problem in Chinese.)