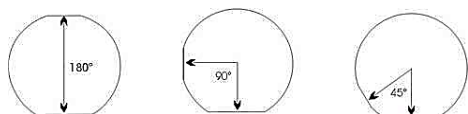


I. Explain the following terms: (20%)

1. invariant point
2. solidus
3. phase diagram
4. Lever rule
5. isomorphous system
6. Segregation
7. LED
8. Bandgap (E_g)
9. Doping
10. Plain-carbon steels

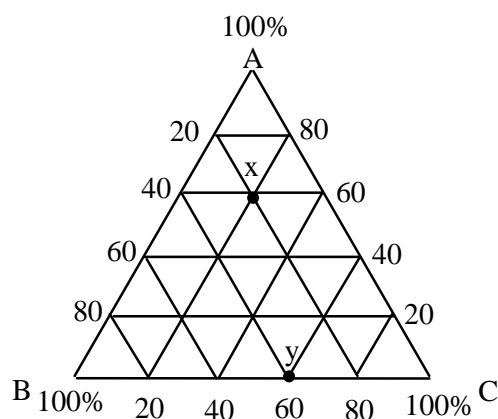
II. Short answers: (30%)

1. Compare the temperature dependence of the conductivity for metals and intrinsic semiconductors. Briefly explain the difference in behavior.
2. Why in the old times (up to the 150 mm wafer diameter era), wafers had flats? (Hint: wafer flats 中文稱：晶圓的平坦邊。)



3. How is electrical conductivity related numerically to electrical resistivity?
4. What are the three basic elements of a bipolar junction transistor(雙載子接面電晶體, BJT)?
5. Define p-type extrinsic silicon semiconductors.
6. Describe the three allotropic forms of pure iron.
7. What is non-equilibrium solidification?
8. MOS 的 M、O、S 分別代表什麼意思?
9. 請描述導線截面積與長度對於電阻的影響。
10. 請畫出二極體中 **P 極**、**N 極**與**空乏區**之相對位置, 並且清楚標明電子、電洞, 在各部份的分佈情形。

III. What is the composition of (a) point x and (b) point y in figure? (4%)

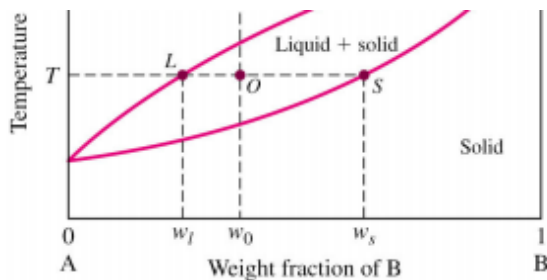


IV. 單選題: (16%)

1. P is the number of phases in thermodynamic equilibrium, F is the number of degrees of freedom, and C is the number of components in a system. The Gibbs phase rule is (A) $P+C=F+2$, (B) $F+C=P+2$, (C) $P+F=C+2$, (D) $P+C+2=F$, (E) none of above.
2. How is SiO_2 removed (use what chemical solution) in the fabrication of a microelectronic integrated circuit? (A) $\text{HCl}_{(\text{aq})}$, (B) $\text{H}_2\text{SO}_{4(\text{aq})}$, (C) $\text{HNO}_{3(\text{aq})}$, (D) $\text{HF}_{(\text{aq})}$.
3. For the reaction: $\gamma \rightarrow \alpha + \text{Fe}_3\text{C}$, please specify the type of phase transformation: (A) eutectoid, (B) eutectic, (C) peritectic, (D) monotectic.
4. 下列何者敘述**錯誤**?
(A) 當溫度升高時, 一般金屬導體電阻增加
(B) 當溫度升高時, 一般半導體電阻下降
(C) 在 p 型半導體裡, 主要載子是電洞
(D) 在 n 型半導體裡, 電洞的濃度將隨溫度升高而減少。
5. Which of the following statements is **true** about n-type silicon? (A) It is produced by doping Si with B or Al, (B) Hole are the mobile charge carriers, (C) It does not conduct electricity as well as pure Si, (D) It is produced by doping Si with P or As, (E) none of above.
6. Which one of the following is called for Fe_3C ? (A) Pearlite, (B) Austenite, (C) martensite, (D) Cementite, (E) Ferrite.
7. How many phases are in a solid solution? (A) 1, (B) 2, (C) 3, (D) 4, (E) none of above.
8. Why is silicon the most common used semiconductor in industry? (A) fashion, (B) abundance, (C) black, (D) expensiveness.

V. What are the majority and minority carriers in an n-type silicon semiconductor?(各 2%) In a p-type one? (各 2% , 總共 4 組答案共 8 分)

VI. Derive the lever rule(推導槓桿定理). (5%)



w_0 : average weight fraction B in phase mixture

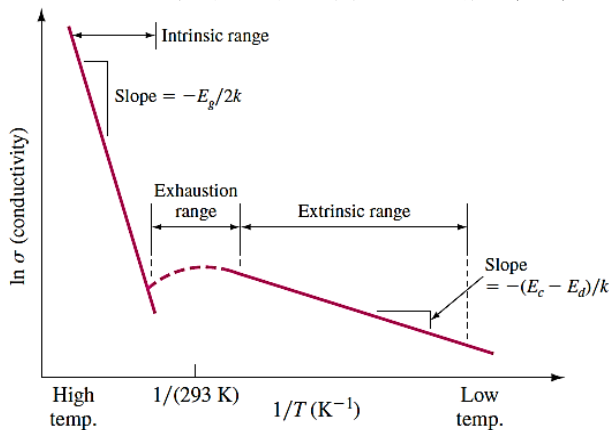
w_L : weight fraction of B in liquid phase

w_S : weight fraction of B in solid phase

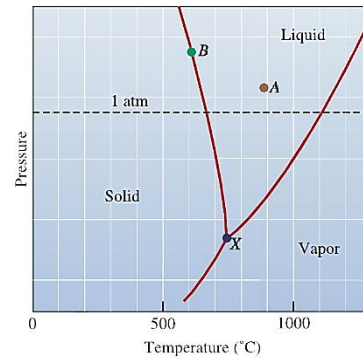
X_S : the weight fraction of solid

X_L : the weight fraction of liquid

VII. Please explain following figure.(請詳細描述溫度對半導體導電載子的影響) (5%)



VIII. In follow figure (右上方), determine the degree of freedom, F, according to the Gibbs rule at the following points: (a) A, (b) B, (c) X, (d) what's name of point X? (8%)



題目 VIII 的圖

IX. In Fig. 8.12, determine the degree of freedom, F, according to the Gibbs rule at the following points: (a) Inside the α region, (b) Inside the $\alpha + \beta$ region, (c) At the eutectic point. (6%)

X. An alloy of 30wt% Pb–70wt% Sn is slowly cooled from 250°C to 27°C (see Fig. 8.12).

(a) Is this alloy hypoeutectic or hypereutectic? (2%)

(b) What are the amounts and compositions of each phase that is present at 183°C+ ΔT ? (4%) (Liquid and β)

(c) What is the amount and composition of each phase that is present at 183°C- ΔT ? (α , total β , eutectic, and proeutectic β) (8%)

XI. 以電子能帶結構 (價帶、導帶、能隙) 方式討論導電度在金屬、半導體, 和絕緣體的差異理由 (可畫圖示意)。 (6%)

XII. Briefly state the Hume-Rothery rules and explain the rationale (基本原理), 共四點. (4%)

XIII. In follow microstructure of Hypoeutectoid plain-carbon steel, what is the phase of (a) the white region, (b) the dark region (4%) .

