Materials Science
FINAL EXAM

Jan. 15, 2014

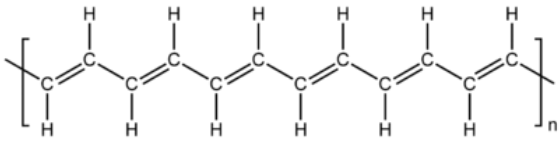
I. Explain the following terms: (20%)

1. Solar cell
2. Energy gap
3. liquidus
4. mask (Photomask)
5. isomorphous system
6. Quench
7. Allotropy
8. diode
9. Pig iron
10. Non-equilibrium solidification

II. Short answers: (33%)

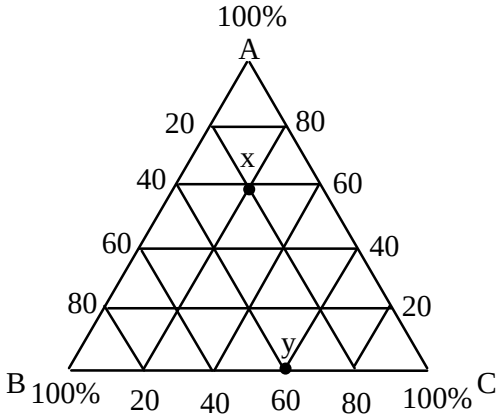
1. List two elemental semiconductor materials and one compound semiconductor material.
2. Please explain why is silicon the most common used semiconductor in industry?(Please give at least two reasons)
3. What is the principal difference between natural and artificial aging processes?
4. Can all alloy compositions be strengthened using precipitation hardening? Why or Why not?
5. Define the term "**austenitizing**".
6. Why is graphite electric conductor? (Explain your answer from the **structure** point of view)
7. Is polyacetylene (PA, 聚乙炔,a polymer material) an electric conductor ? Why?

   Hint:



8. How is SiO_2 removed (Silicon dioxide)?(Use what chemical solution)in the fabrication of a microelectronic integrated circuit?
9. Describe the three allotropic forms of pure iron.
10. How many phases are in a solid solution? Why?
11. Write equations for the following invariant reactions: eutectic and peritectic. How many degrees of freedom exist at invariant reaction points in binary phase diagrams?

III. What is the composition of (a)point *x* and(b)point *y* in figure?(6%)

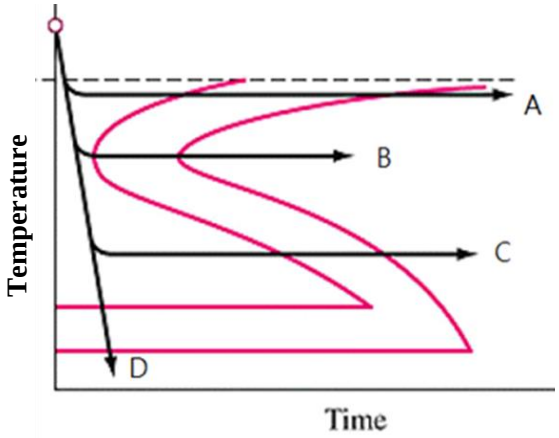


IV. 單選題(Multiple choice, only one answer): (21%)

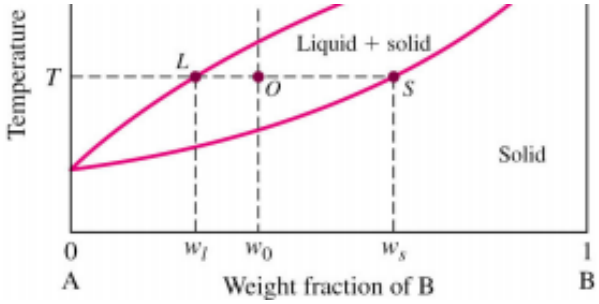
1. P is the number of phases in thermodynamic equilibrium, F is the number of degrees of freedom, and C is the number of components in a system. The Gibbs phase rule is (A)P+C=F+2,(B)F+C=P+2,(C)P+F=C+2,(D)P+C+2=F,(E)none of above.
2. In a two-component system, the maximum number of phases can co-exist(幾個相共存) at a fixed pressure is(A)1, (B) 2,(C)3,(D) 4, (E) 5,(F)6,(G)0.
3. For the reaction: liquid solution + solid solution = solid solution, please specify the type of phase transformation:(A) eutectic,(B)eutectoid,(C)peritectic,(D)monotectic,(E)none of above.
4. Which of the following transformations does not involve diffusion? (A)precipitation transformations, (B)martensitic transformations, (C)order-disorder transformations,(D) eutectoid transformations, (E)none of above.
5. Which one of the following is called for Fe_3C?(A)Pearlite, (B)Austenite, (C)martensite,(D)Cementite, (E)Ferrite, (F)none of above.
6. Which of the following statements is true about P-type silicon? (A)It is produced by doping Si with P or As, (B)Electron are the mobile charge carriers, (C)It does not conduct electricity as well as pure Si,(D)It is produced by doping Si with B or Al,(E)none of above.
7. Which of the following **cannot** be found from a one-component phase diagram?(A)boiling

point,(B)melting point,(C)heat capacity,(D)triple point,(E)none of above.

V. What microstructures can you obtain after the following four heat treatments of a plain-carbon eutectoid steel? (8%)



VI. Derive the lever rule(推導槓桿定理). (6%)



w_0:average weight fraction B in phase mixture

w_L:weight fraction of B in liquid phase

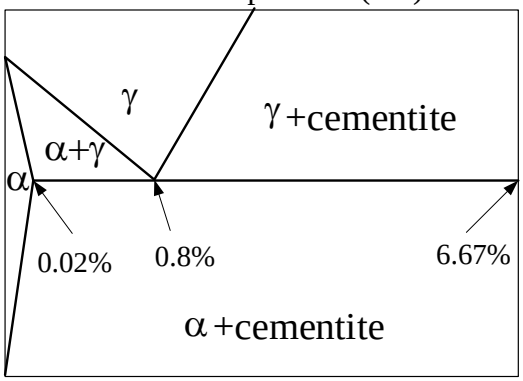
w_S: weight fraction of B in solid phase

X_S: the weight fraction of solid

X_L: the weight fraction of liquid

VII. Describe the strengthening mechanism and processing steps for the precipitation strengthening of Al alloys.(8%)

VIII. Compute the mass fractions of α-ferrite and cementite in pearlite. (6%)



IX. In Fig. 8.12, determine the degree of freedom, F, according to the Gibbs rule at the following points:(a) At the melting point of pure tin, (b) Inside the α region, (c) Inside the α+β region, (d) At the eutectic point. (8%)

X. An alloy of 30wt% Pb–70wt% Sn is slowly cooled from 250℃ to 27℃ (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℃+ΔT? (4%) (Liquid and β)

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

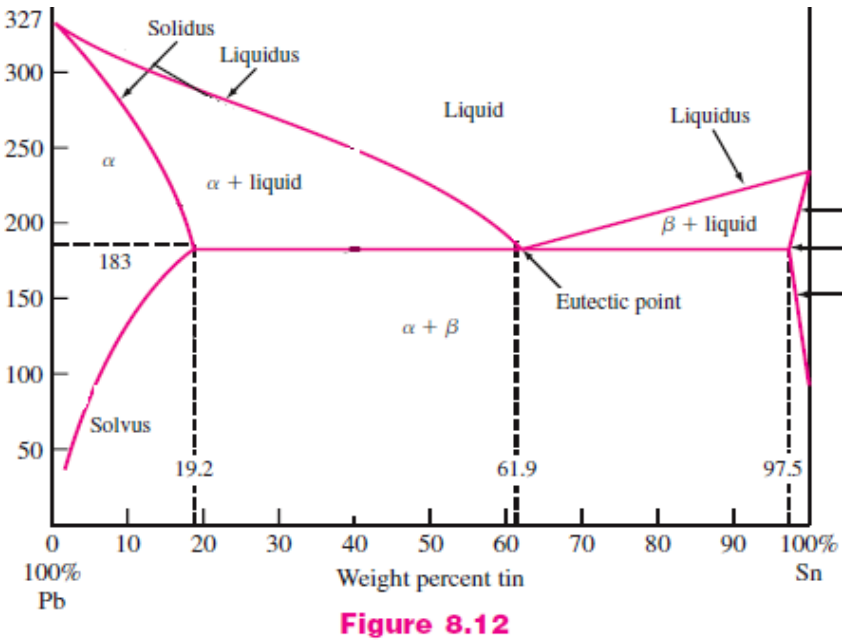


Figure 8.12