

國立臺灣海洋大學 101 學年度研究所碩士班暨碩士在職專班入學考試試題  
考試科目：材料導論  
系所名稱：材料工程研究所碩士班甲組

1. 答案以橫式由左至右書寫。2. 請依題號順序作答。

**Section (A) 30% (each equation: 3%)**

1. The combination of the slip plane and the slip direction is termed the slip system. Which of the following item represents the slip system for FCC:  
(a)  $\{112\} \langle 110 \rangle$  (b)  $\{112\} \langle 111 \rangle$  (c)  $\{111\} \langle 110 \rangle$  (d)  $\{100\} \langle 110 \rangle$
2. Which of the following metal has a clear ductile to brittle transition temperature:  
(a) Mo (b) Zn (c) W (d) Cu
3. Which of the following semiconductor belongs to extrinsic semiconductor:  
(a) Ge (b)  $\text{SnO}_2$  (c) ZnO (d) Boron-doped Si
4. Which of the following phenomenon can **not** be observed for plastically deforming a polycrystalline metal specimen at temperatures that are low relative to its absolute melting temperature:  
(a) A change in grain shape (b) Strain hardening (c) An increase in ductility (d) An increase in dislocation density
5. Which of the following metal has a relative low recrystallization temperature:  
(a) W (b) Ni (c) Zn (d) Cu
6. Hardness is a measure of a material's resistance to localized plastic deformation. Which of the following test technique is **not** for hardness test:  
(a) Brinell (b) Vickers (c) Brazing (d) Knoop
7. Atomic defects involving host atoms may exist in ceramic compounds. As with metals, both vacancies and interstitials are possible; however, since ceramic materials contain ions of at least two kinds, defects for each ion type may occur. Which of the following defect type involves a cation-vacancy and a cation-interstitial pair:  
(a) Anion vacancy (b) Frenkel defect (c) Pitting (d) Schottky defect
8. Which of the following method can **not** increase the conductivity of the direct bandgap semiconductor:  
(a) An increase in operation temperature (b) Doping (c) An increase in operation pressure (d) Lightning
9. In addition to slip, plastic deformation in some metallic materials can occur by the formation of mechanical twins, or twinning. These two processes differ from one another in several respects. Which of the following statement is **not** true:  
(a) For slip, the crystallographic orientation above and below the slip plane is the same before and after the deformation (b) The atomic displacement for twinning is larger than the interatomic separation (c) For twinning, there will be a reorientation across the twin plane (d) Slip occurs in distinct atomic spacing multiples.

10. Which of the following defect belongs to linear defects:

- (a) Grain boundary (b) Mixed dislocation (c) Twin boundary (d) Stacking fault.

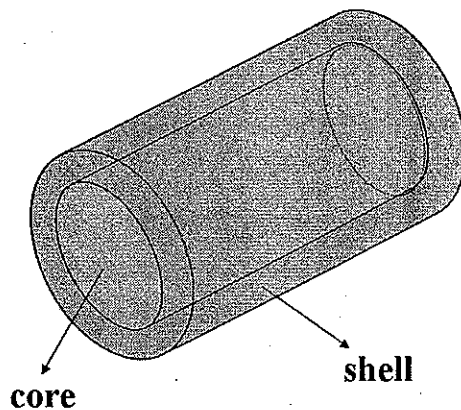
**Section (B) 20%**

1. The Kirkendall effect is a classical phenomenon in metallurgy. Recently, this mechanism has been widely used to synthesize new functional nanostructures.

(a) Please describe the Kirkendall effect (5%)

(b) Spinel  $\text{ZnAl}_2\text{O}_4$  nanostructures can be formed via a thermally induced interfacial solid-solid reaction of  $\text{ZnO-Al}_2\text{O}_3$  core-shell nanowires (as shown in Figure 1). The in-diffusion of the shell material is slower than the out-diffusion of the core material. The solid-state reaction temperature is high and time is long enough for the reaction. The relative thickness for the core to shell nanolayer is adjusted to form the pure  $\text{ZnAl}_2\text{O}_4$  nanostructures. **Based on the Kirkendall effect, what kind of the morphology of the  $\text{ZnAl}_2\text{O}_4$  nanostructures will be formed after the solid-state reaction?** (6 %)

(a) core-shell nanostructure



(b)

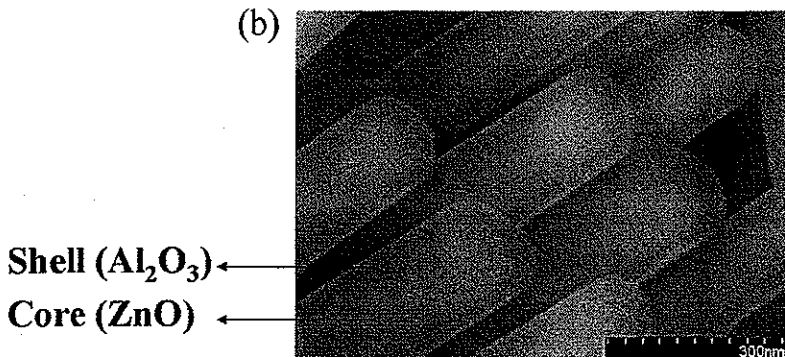


Figure 1. Schematics of the  $\text{ZnO-Al}_2\text{O}_3$  core-shell nanowires.

2. For the cold-worked metals or alloys, the properties and structures may revert back to the precold-worked states by appropriate heat treatment. Such restoration results from two different processes that occur at elevated temperatures: recovery and recrystallization, which may be followed by grain growth. **Please describe three factors in detail that markedly affect the rate of recrystallization.** (9 %)

**Section (C) 50%**

1. What's the electronic structure of copper with an atomic number of 29? (4%)
2. Calculate the packing factor for the cubic close-packed structure cell. (4%)
3. What's "brass"? (A) Cu-Sn (B) Cu-Zn (C) Cu-Au (D) Cu-Al. (2%)
4. Demonstrate the four criteria for forming a substitutional solid solution binary alloy. (Hume-Rothery rules) (8%)
5. Derive the level rule, which applies to a binary phase diagram. (4%)
6. Define the terms eutectic and eutectoid reactions. (8%)
7. What is the principle of precipitation hardening? (4%)
8. What the driving force to sintering? (4%)
9. Explain the following heat treatments: (a) austenitizing, (b) normalizing, and (c) quenching. (12%)