109MM02

國立臺北科技大學 109 學年度碩士班招生考試

系所組別：3301 材料科學與工程研究所

第二節　材料科學與工程導論　試題（選考）

注意事項：

1. 本試題共八題，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. Compare the following properties and temperatures for those of pure copper and Cu-30 wt%Zn alloy. Which one possesses better property or higher temperature under same condition? Why?
   (a) tensile strength (2%)
   (b) electrical conductivity (2%)
   (c) thermal conductivity (2%)
   (d) melting temperature (2%)
   (e) recrystallization temperature (2%)

2. Tungsten has a body-centered cubic structure with a lattice parameter of 0.316 nm.
   (a) Compute the atomic radius of tungsten. (4%)
   (b) Compute the planar density (atom/cm^2) for (111) plane. (4%)
   (c) What is the Burgers vector for tungsten? And determine its magnitude. (4%)
   (d) If a tensile stress 2.5 MPa is applied in the [021] direction of a tungsten single crystal, compute the resolved shear stresses for the slip systems on the (110) plane. (6%)

3. The MgO has the sodium chloride (or rock salt) crystal structure. If the angle of diffraction for the (311) set of planes occurs at 80.32° (first-order reflection) when monochromatic x-radiation having a wavelength of 0.154 nm is used.
   (a) Compute the interplanar spacing for (311) plane. (4%)
   (b) Compute the ionic radius of Mg^{2+}, if the ionic radius of O^{2-} is 0.132 nm. (4%)
   (c) Which set of planes will be diffracted at the lowest diffraction angle? (3%)
   (d) What is the Bravais lattice of MgO? (3%)

4. Pores represent the most important defect in polycrystalline ceramics. A ceramic part is produced by sintering alumina powder. It weighs 160 g when dry, 184 g after it has soaked in water, and 116 g when suspended in water. The specific gravity of alumina is 3.96 g/cm^3.
   (a) Explain the meaning of apparent porosity and true porosity. (4%)
   (b) Calculate the apparent porosity and true porosity. (6%)

5. (a) Explain the meaning of annealing (full anneal) and normalizing heat treatments for steels. (4%)
   (b) Explain the difference in austenitizing temperature between annealing and normalizing for a hypereutectoid steel. Why? (8%)

6. Some aircraft component is fabricated from an aluminum alloy that has a plane strain fracture toughness of 36 MPa$\sqrt{m}$. It has been determined that fracture results at a stress of 400 MPa when the maximum (or critical) internal crack length is 2.0 mm.
   (a) Explain the meaning of fracture toughness. (4%)
   (b) For this same component and alloy, will fracture occur at a stress level of 470 MPa when the maximum internal crack length is 1.2 mm? Why or why not? (8%)

7. Consider a hypothetical eutectic phase diagram for metals A and B at the eutectic temperature giving the following information: The solubility of B in A (α phase) is 8 wt%, the solubility of A in B (β phase) is 12 wt%, the eutectic reaction occurs at 40 wt% B. If an alloy contains 44 wt% of α phase and 56 wt% of β phase at the eutectic temperature.
   (a) Calculate the composition of the alloy. (4%)
   (b) Calculate the amounts of each microconstituent at the temperatures just above and below the eutectic point. (8%)

8. (a) What are forward bias and reverse bias for a *p*-*n* rectifying junction? (4%)
   (b) Plot a current-voltage characteristic (I-V curve) to explain electron and hole motions in a *p*–*n* junction for forward and reverse biases. (8%)