國立台灣科技大學九十五學年度碩士班招生試題

系所組別： 機械工程系碩士班戊組

科　　目： 工程材料

總分 100 分

1. Molybdenum, which has a body-centered cubic structure, has a theoretical density of 10.22 g/cm^3. The molar mass of molybdenum is 95.94 g/mol and the Avogadro's number is 6.02 X 10^{23} atoms/mol. Based on these data, calculate the lattice constant and atomic radius of molybdenum and show your results using the unit of nm. (10 分)

2. The low elastic constant and low yield strength of copper limit its applications in many fields. How would you increase these properties of copper? Show at least three strengthening approaches in your answer. (10 分)

3. The efficiency of solid oxide fuel cell depends strongly on the flux rate of oxygen ions through the zirconia electrolyte, an event caused by the diffusion of oxygen ions in the zirconia electrolyte. Show at least two means by which you can increase the flux rate of oxygen ions through the zirconia electrolyte, based on Fick's first law. (10 分)

4. Which of the following intrinsic semiconductors are fully transparent to visible light at 300 K? (Plank's constant = 4.41 X 10^{-15} eV-s, c = 3 X 10^8 m/s, wavelength of red color = 0.7 μm, wavelength of violet color = 0.44 μm) (10 分)

Material	Band Gap (eV) at 300 K
Si	1.11
Ge	0.66
InSb	0.17
InAs	0.36
InP	1.27
GaP	2.25
GaAs	1.43
GaSb	0.68
CdSe	1.74
CdTe	1.44
ZnO	3.2
ZnS	3.6

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5. Describe the desired properties of a soft magnetic material, such as permeability, coercivity, saturated magnetization, and electrical resistivity, in applications involving frequencies up to 1 kHz. (10 分)

6. A material contains internal flaws as large as 0.80 mm in length. The plane strain fracture toughness of this material is 50 MPa$\sqrt{m}$ and the tensile strength is 600 MPa. In mode I situation, will the stress cause the material to fail before the tensile strength is reached? Assume the geometry factor Y = 1. (10 分)

7. Drawing a stress-strain curve, explain the term "strain hardening" means. What is the mechanism to cause the strain-hardening? (10 分)

8. A steel contains 45% pearlite and 55% ferrite at room temperature obtained after a normalizing treatment. Please to estimate the carbon content of this steel and the total amount of the ferrite phase. (10 分)

9. Solid-state sintering involves several mass-transport mechanisms. What mechanisms can cause densification and what is the driving force for this solid-state sintering? (10 分)

10. What are the two important stages happened in the transformation of molten metals into crystalline metals? Explain the effect of undercooling on this transformation. (10 分)