

# 國立交通大學 101 學年度碩士班考試入學試題

科目：材料科學與工程導論(3152)

考試日期：101年2月17日 第4節

系所班別：材料科學與工程學系

組別：材料系甲組

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【可使用計算機】\*作答前請先核對試題、答案卷(試卷)與准考證之所組別與考科是否相符!!

1. A single crystal of zinc is oriented for a tensile test such that its slip plane normal makes an angle of  $65^\circ$  with the tensile axis. Three possible slip directions make angles of  $30^\circ$ ,  $48^\circ$ , and  $78^\circ$  with the same tensile axis. (a) Which of these three slip directions is most favored? (b) If plastic deformation begins at a tensile stress of 2.5 MPa, determine the critical resolved shear stress for zinc. (8+7 points)
2. Explain how grain refining can strengthen metals. List two methods for grain refining. (5+5 points)
3. A cylindrical rod 500 mm long, having a diameter of 12.7 mm (0.50 in.), is to be subjected to a tensile load. If the rod is to experience neither plastic deformation nor an elongation of more than 1.3 mm (0.05 in.), when the applied load is 29,000 N, which of the four metals or alloys listed below are possible candidates? Justify your choice(s). (10 points)

Material	Modulus of Elasticity (GPa)	Yield Strength (MPa)	Tensile Strength (MPa)
Aluminum alloy	70	255	420
Brass alloy	100	345	420
Copper	110	210	275
Steel alloy	207	450	550

4. In general, a material would increase its volume with increasing temperature. What are the causes for the increased volume? What are the reasons that some materials demonstrate a smaller volume upon increasing temperature? (5+5 points)
5. Please explain what are twin and twin boundary. Please explain the difference between mechanical and annealing twins. (5+5 points)
6. Please calculate the exact radius (in nm) of a Cu spherical particle that has only one vacancy in its structure. The temperature is  $1000^\circ\text{C}$ , the energy for vacancy formation is 0.9 eV/atom, the atomic weight and density are 63.5 g/mol and  $8.4\text{ g/cm}^3$ , respectively. (10 points)
7. Between polypropylene and phenol-formaldehyde, which polymer can be easily grounded, recycled, and reused after proper processing? State your reason. (2+3 points)
8. Please identify the polymer with higher  $T_m$  in the following pairs and explain why  
(a) Polyethylene vs. Polystyrene  
(b) linear polyethylene vs. branched polyethylene  
(3+3 points)
9. Please briefly describe three types of polarization, which may affect the dielectric behavior of a material (2+2+2 points)

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10. How will the electrical conductivity of (a) pure Cu and (b) pure Ge vary with temperature (50 to 1000 °K)? Please sketch the temperature dependence in an electrical conductivity vs temperature plot, separately. (3 points+3 points)

11. Please explain why ceramics are more brittle than metals. (5 points)

12. What is Schottky defect? (3 points) What is the number of Schottky defects per cubic meter in KCl at 550 °C? (4 points)?

The energy required to form each Schottky defect is 2.6 eV, while the number of lattice sites per cubic meter is  $1.58 \times 10^{28}$ .