國　立　清　華　大　學　命　題　紙

97 學年度　工程與系統科學系　系（所）甲　組碩士班入學考試

科目物理冶金 科目代碼 2801 共 2 頁第 1 頁 *請在【答案卷卡】內作答

1. (a) Given a small angle tilt grain boundary whose angle of tilt is 0.2 deg., please find the spacing between dislocations in the boundary if the Burgers vector of the dislocations is 0.3 nm. (b) On the assumption that the energy of an edge dislocation is given by $E_e = Gb^2\ln(4r/b)/4\pi(1-\upsilon)$, where $G=9\times10^4$ MPa, r=d/2, and $\upsilon=0.33$, please determine an approximate value for the surface energy of the tilt boundary. (10%)
2. Assume that a spherical precipitate particle forms in an aging hardening alloy and that the volume free-energy change associated with the formation of the particle is 60 MJ/m^3. The energy of the interface between the particle and the matrix is 0.40 J/m^2. (a) Please determine the critical radius r_0 and the free-energy change at that radius ΔG_{r0}. (b) Please draw the free energy of a particle as a function of its radius. (c) If the precipitate has a total volume fraction of 1.5% and the particles are all of the same size $r = 2\ r_0$, compute the number of particles per cubic meter. (d) Compute the total change in free energy due to the formation of all the precipitate particles in a cubic meter in (c). (12%)

3. (a) Determine the vacancy concentration of each element at its melting point as follows: Al, 0.76 eV, 660°C; Cu, 0.90 eV, 1083°C; Ni, 1.4 eV, 1453°C. (b) Determine the jump rate of Cu both at 25 °C and 1083°C, respectively. (H_m=121KJ/mol.) c) There is some evidence that the vacancy concentration at the melting point may become so large and the jump rate so high that it is no longer possible for a macroscopic crystal to exist. Do the results of this problem support this view? Explain. (8%)

4. (a) Please draw a creep test curve and indicate the three stages in the curve. (b) Explain the basic features of these three stages. (c) How does temperature affect the creep curve? (d) How about the effect of stress? (e) Give a general equation to indicate the relationship between strain rate, applied stress, and temperature in a creep test. (10%)

5. (a) Is it possible to deform a zinc single crystal to very large plastic strains at temperatures below room temperature? (b) How about for a polycrystalline zinc? Please give an explanation for them based on the mechanical properties of zinc. (10%)

6. Consider an insulated chamber with two equally sized compartments that are separated from each other by a removable partition. Initially, one side contains a mole of ideal gas A and the other side contains a mole of ideal gas B, with both gases at a pressure of 0.1013 MPa and a temperature of 298 K. Now assume the partition is removed. (a) Will there be a change in the temperature of the gas? Explain. (b) How large will the enthalpy change be? c) Compute the value of the entropy change. (d) Compute the Gibbs free energy change. Is the magnitude of this change significant? Explain. (12%)

7. (a) Please draw the following planes in a hexagonal close-packed unit cell, (01-11), (-12-12), (10-10), and (0001). (b) Please draw the following lines in a hexagonal close-packed unit cell, [11-20], [-1011], [2-1-13], and [0001]. (8%)

8. The total line length of the dislocations in a 5 cm by 5 cm TEM micrograph, of a stainless steel foil, taken at 40,000 X is 500 cm. The specimen imaged by the picture had a thickness of 100 nm, determine the dislocation density in the foil. (10%)

9.(a) Please describe the meaning of "fatigue". (b) Draw a S-N curve for ferrous metals and define the fatigue limit. (c) Also draw a S-N curve for nonferrous metals and define the fatigue strength. (d) Describe the distinctive features of the fatigue fracture surfaces. (e) Draw the schematic diagram and explain the mechanism of fatigue crack propagation. (10%)

10. (a) Explain "miscibility gap" in a binary phase diagram, state the necessary conditions for it to occur. (b) Explain "superlattices", also state the necessary conditions for it to occur. (c) List an example for the cases of (a) and (b), respectively. (10%)