國立清華大學命題紙

99學年度 工程與系統科學系甲組 碩士班入學考試

科目 物理冶金 科目代碼 2601 共 3 頁，第 1 頁 *請在【答案卷卡】作答

1. (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%)

2. Please design an experiment to measure the intrinsic diffusivities of the element A and B in a substitutional solid solution. (a) Describe the setup of your experiment. (b) Write down the idea and equations that you are going to use to resolve your experimental data in order to get the right answer. (c) Make necessary assumptions and data to actually solve the intrinsic diffusivities of element A and B in an alloy. (d) Explain the importance of this experiment. (20%)

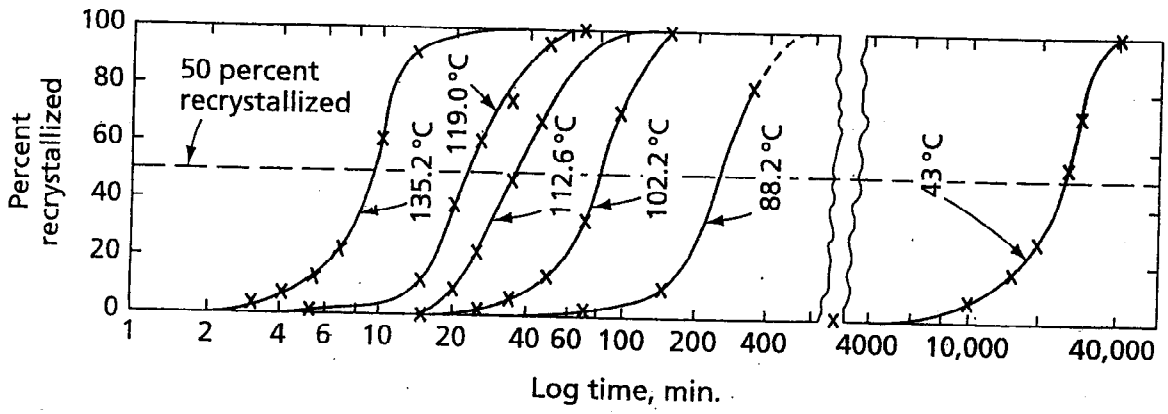
3. (a) Please draw a creep test curve and indicate the three stages in the curve. (b) Explain the basic features of these three stages. (c) How does temperature affect the creep curve? (d) How about the effect of stress? (e) Give a general equation to indicate the relationship between strain rate, applied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

4. 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. (e) Is the magnitude of this change significant? Explain. (10%)

5. 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). (e) It is known that the Orowan mechanism can be expressed as: σ (Mpa) = $5.9f^{1/2}/X.\ln(X/b)$, where b=0.25 nm (Burgers vector), X is the particle diameter, f is the volume fraction of precipitate, please calculate the Orowan stress for this material. (15%)

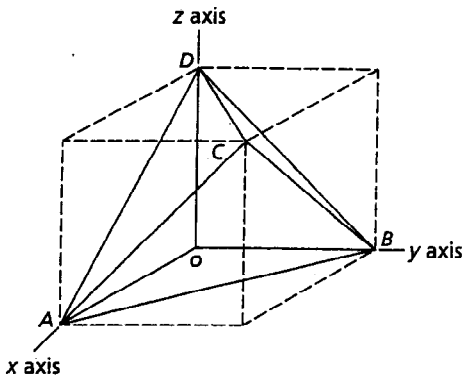
6. One way to study the recrystallization process is to plot isothermal recrystallization curves of the type as the following figure. Each curve represents the data for given temperature and shows the amount of recrystallization as a function of time. Data for each curve of this type are obtained by holding a number of identical cold-worked specimens at a constant temperature for different lengths of time. After removal from the furnace and cooling to room temperature, each specimen is examines metallographically to determine the extent of recrystallization. (a) Use the data in the figure to determine the activation energy Q and the preexponential constant A in the rate equation for recrystallization. (b) Determine the recrystallization temperature for the copper. (c) How long will it take to completely recrystallize the copper at room temperature? (d) Also use the figure to calculate the activation energy for 50% of the structure is recrystallized. (e) Please explain the meaning of the activation energy Q in this type of experiments. (15%)



Isothermal transformation (recrystallization) curves for pure copper (99.999 percent Cu) cold-rolled 98 percent. (From Decker, B. F., and Harker, D., *Trans. AIME*, **188** 887 [1950].)

7. The total line length of the dislocations visible in a 5 cm by 6 cm TEM photograph of a metal specimen, taken at a magnification of 10,000X is measured as 500 cm. The specimen imaged by this picture had a thickness of 200 nm. Please determine the dislocation density in the specimen. (6%)

8. Please determine the proper Miller indices of the planes of ABC, ABD, ACD, and BCD in the following diagram which is known as the Thompson Tetrahedron. (8%)



9. Determine the hexagonal close-packed lattice directions of the lines ***rt, ut*** and ***uv*** in the following figure. (6%)