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中正大學機械系 98 學年度上學期工程材料學期末考試題 99.1.14

1.可用計算機 2.不可用字典 3.Close-book 4. Total score: 120 敖仲寧老師

1. Figure 1 shows a phase diagram for Cu and Ni. (25%)

(a) Draw schematically on fig.1 the development of microstructure during **NON-EQUILIBRIUM** solidification of a 35wt%Ni—65wt%Cu alloy at point b, c, d, e, and f. (10%)

(b) During **NON-EQUILIBRIUM** solidification, the concentration of solidified grains is not uniform. What do we call this phenomenon? (2%)

(c) During **NON-EQUILIBRIUM** solidification, will the 35 wt% Ni - 65wt%Cu alloy completely solidify at a temperature higher or lower than the solidification temperature at equilibrium solidification? What do we call this phenomenon? (2%)

(d) What do we call this type of phase diagram? (2%)

(e) Determine the wt% of solid phase α and wt% of liquid phase at temperature c during **EQUILIBRIUM** solidification. (4%)

(f) Explain schematically how we construct this phase diagram from experiment. (5%)

Make Drawing on Fig.1 and submit it together with the answer sheets.

2. Figure 2 shows a Cu-Ag phase diagram. (40%)

(a) What do we call this type of phase diagram? Briefly describe the meaning of the points B, E, and G. (8%)

(b) If a Cu-Ag alloy contains 83% Ag as shown along line A and a Cu-Ag alloy contains 95% Ag as shown along line B, draw schematically in the circles on Fig.2 the microstructure developed at each specific temperature as the alloy cooling down from high temperature along line A and line B. Indicate the phases of the microstructures. (9%)

(c) If a Cu-Ag alloy contains 20% Ag (line C), what phase would first solidify from liquid? Determine the mass fraction of this pro-eutectic phase when the temperature almost reaches T_E. (6%)

(d) Continued from (c), if the temperature further decreases till slightly below T_E, what would happen to the rest of liquid? What is the concentration of the pro-eutectic phase and what are the concentrations of the eutectic α and eutectic β? (8%)

(e) Continued from (d), determine the mass fraction of the pro-eutectic phase, the mass fraction of total α and total β. (9%)

Make Drawing on Fig.2 and submit it together with the answer sheets.

3. **Consider a hypothetical eutectic phase diagram for metal A and B.** The phase rich in A is an α phase and the phase rich in B is a β phase. The maximum solubility of metal B in A at eutectic temperature is C_α=12 wt%. The eutectic composition is 36 wt% A and 64 wt% B.

(a) Find the composition C_o of alloy A-B which will yield the alloy containing primary β mass fraction= 0.367 and total β mass fraction= 0.768. (7%)

(b) Also find the maximum solubility of metal A in metal B C_β (wt%)at eutectic temperature. (7%)

(Hint: you need to solve simultaneous equations to find the solutions of (a) and (b).)

(c) If the microstructure of this alloy A-B at temperature slightly below T_E is shown in figure 3, answer the questions on figure 3. If you could not solve (a) and (b), then assume C_o= 70 wt% for convenience. (6%)

Answer 3(c) on Fig.3 and submit it together with the answer sheets.

4. Figure 4 is a Mg-Pb phase diagram. (20%)

(a) Label the blank areas with proper phase(s). (5%)

(b) What happen to this alloy if the wt% of Pb is exactly 81%? What do we call this phase diagram? (5%)

(c) Estimate the eutectic temperature of alloy at Mg 50wt%-Pb 50wt%.(2%)

(d) What is point M? (3%)

(e) Determine the degree of freedom of points on line CD according to Gibbs phase rule. (5%)

Answer 4(a) on Fig.4 and submit it together with the answer sheets.

5. Figure 5 shows the relationship between impact energy and temperature of a steel.

(a) Point P, Q and R denote impact energy at different temperatures. If we observe the fracture surface of impact specimens tested at point P, Q and R, select for P, Q and R an appropriate fractography from the SEM picture A,B, C and D, fill into blank beside P, Q and R . (6%)

(b) Indicate the type of fracture of SEM picture A,B, C and D (9%)

Answer 5 on Fig.5 and submit it together with the answer sheets.