

八十六學年度 工程與系統科學系(所) 組碩士班研究生入學考試

科目 材料科學導論 科號 4011 共 4 頁第 1 頁 \*請在試卷【答案卷】內作答

1. A diffusion couple was formed between pure copper and a copper-nickel alloy. After heating the couple to 1273 K for 30 days, the concentration of nickel in the copper is 10.0 wt% at a position 0.50 mm from the initial copper-alloy interface. What is the original composition of the copper-nickel alloy? The preexponentially and activation energy for the diffusion of Ni in Cu are  $2.7 \times 10^{-4} \text{ m}^2/\text{s}$  and 236,000 J/mol, respectively. The semi-infinite solution of Fick's second law is

$$(C_x - C_c)/(C_s - C_c) = 1 - \text{erf}(x/2\sqrt{Dt})$$

Table Tabulation of Error Function Values

Z	erf(Z)	Z	erf(Z)	Z	erf(Z)
0	0	0.55	0.5633	1.3	0.9340
0.025	0.0282	0.60	0.6039	1.4	0.9523
0.05	0.0564	0.65	0.6420	1.5	0.9661
0.10	0.1125	0.70	0.6778	1.6	0.9763
0.15	0.1680	0.75	0.7112	1.7	0.9838
0.20	0.2227	0.80	0.7421	1.8	0.9891
0.25	0.2763	0.85	0.7707	1.9	0.9928
0.30	0.3286	0.90	0.7970	2.0	0.9953
0.35	0.3794	0.95	0.8209	2.2	0.9981
0.40	0.4284	1.0	0.8427	2.4	0.9993
0.45	0.4755	1.1	0.8802	2.6	0.9998
0.50	0.5205	1.2	0.9103	2.8	0.9999

(15 %)

2. Describe in your own words the four strengthening mechanisms for single phase alloy, namely grain size reduction, solid solution hardening, strain hardening, and precipitation hardening. Be sure to explain how dislocations are involved in each of the strengthening techniques.

(20 %)

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3. Consider 6.0 Kg of austenite containing 0.45 wt % c, cooled to below 727 °C (1341 °F).

- (a) What is the proeutectoid phase ?
- (b) How many kilograms each of total ferrite and cementite form ?
- (c) How many kilograms each of pearlite and proeutectoid phase form ?
- (d) Schematically sketch and label the resulting microstructure.

(20 %)

4. Consider a metal single crystal oriented such that the normal to the slip plane and the slip direction are at angles of 60° and 35°, respectively, with the tensile axis. If the critical resolved shear stress is 3000 psi (20.7 MPa), will an applied stress of 6500 psi (45MPa) cause the single crystal to yield ? If not, what stress will be necessary ?

(15 %)

5. What are the three stages of annealing ? Discuss the driving force for each stage. Describe the changes of microstructure and mechanical properties in each stage.

(15 %)

6.(a) Fill the blank area on the TTT diagram for eutectoid steel shown in Fig.1

- (b) Using Fig.1 to specify the nature of the final microstructure (in terms of microconstituents present) of a small specimen that has been subjected to the following time-temperature treatments. In each case assume that the specimen begins at 760 °C and that it has been held at this temperature long enough to have achieved a complete and homogeneous austenite structure. (1) Cool rapidly to 350 °C, hold for 10<sup>3</sup> s, then quench to room temperature. (2) Rapidly cool to 625 °C, hold for 10s, then quench to room temperature. (3) Rapidly cool to 600 °C, hold for 4s, rapidly cool to 450 °C, hold for 10s, then quench to room temperature. (4) Reheat the specimen in part. (3) to 700 °C for 20hr.

(15 %)

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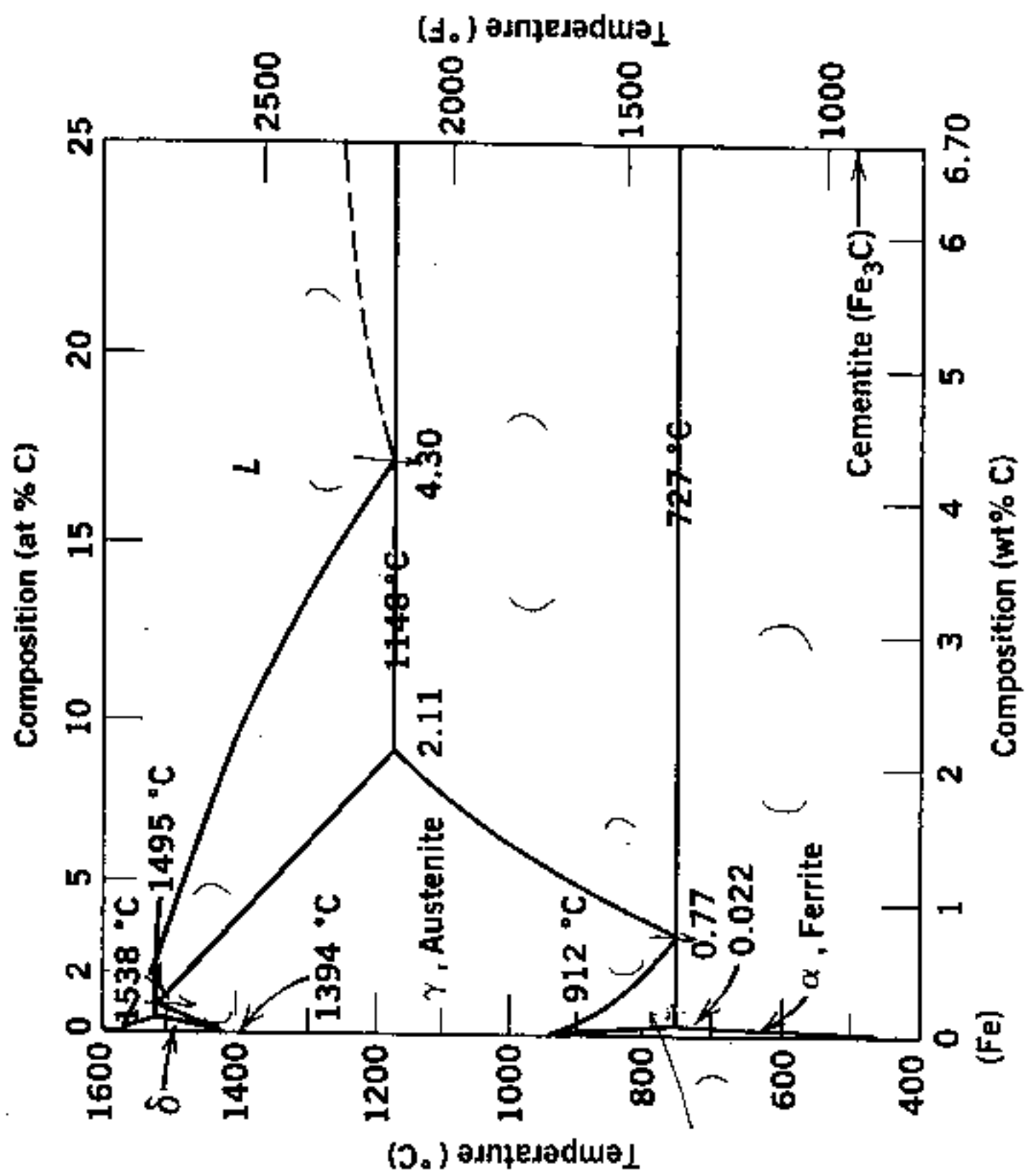


FIGURE 2

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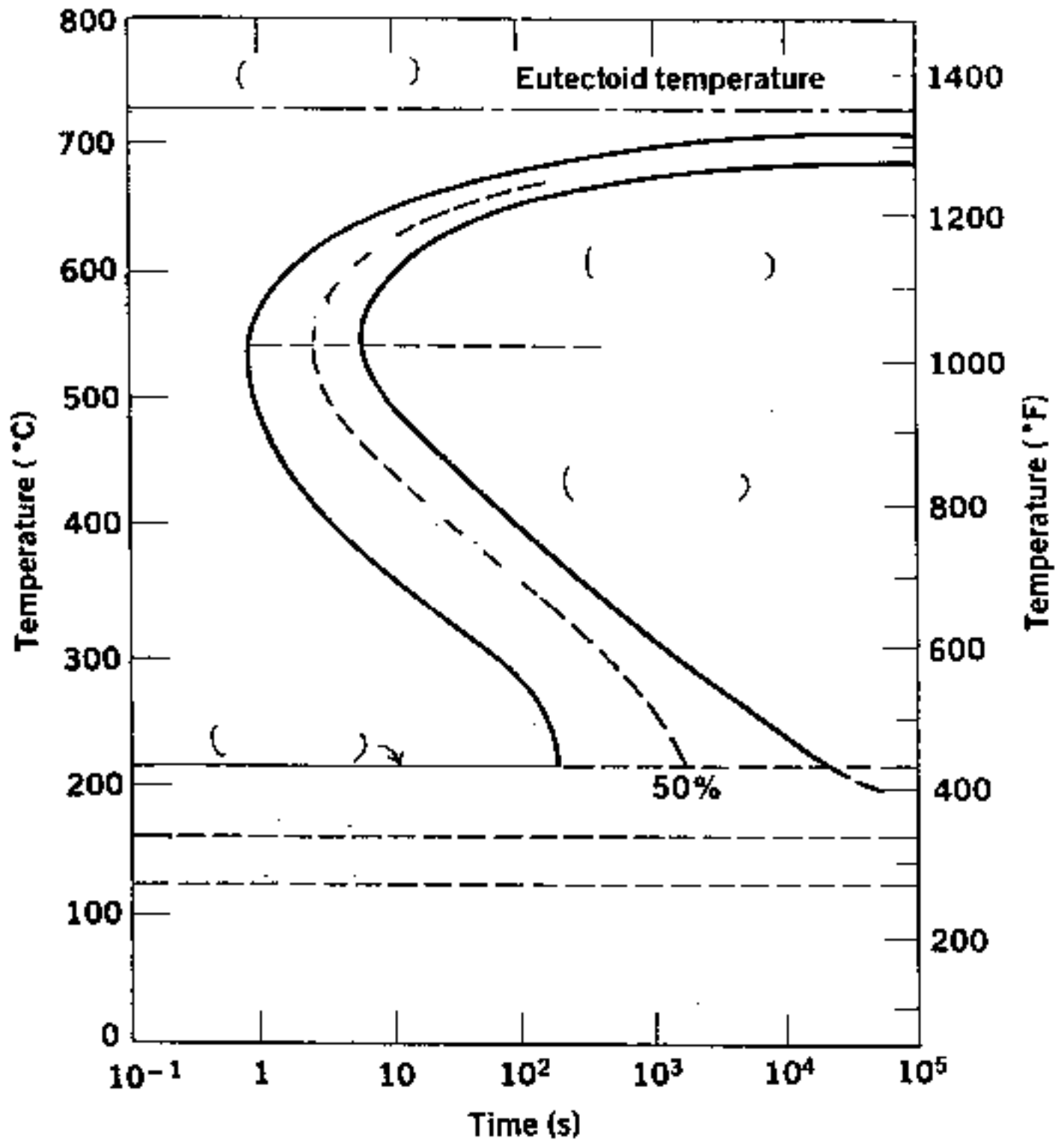


FIGURE 1