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94 Ⅲ

中正大學機械系 94 學年度上學期工程材料學期末考試題 95.1.12

1. 可用計算機 2.不可用字典 3.Closed Book 4 . Total score: 120

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Iso-morphous phase diagram (14%)

1. Using an iso-morphous phase diagram of an alloy shown in Fig. 1, sketch to explain what is ***segregation*** when the alloy cooling under ***non-equilibrium*** solidification? (8%)
2. Sketch and estimate the real concentration of Ni% in liquid and in α phase at temperature T1 under ***non-equilibrium*** solidification. **(Submit Fig.1 together with your answer sheets.)** (6%)

Cu-Zn phase diagram (24%)

3. Fig.2 shows a Cu-Zn phase diagram. A part of Fig.2(a) is enlarged to Fig. 2(b) as shown in Fig.2.
   (a) Estimate the melting point of Cu and Zn in °C. (4%)
   (b) Is it possible to find a Cu-Zn alloy which has a melting point even lower than that of both Cu and Zn metal? Why? (4%)
   (c) Label the 5 blank areas in Fig.2(b) with proper phase symbols. (6%)
   (d) Indicate in Fig. 2(b) the ***peritectic point P*** and ***eutectoid point E*** and give the phase equation of eutectoid reaction occurring in Fig. 2(b). (10%)**(Submit Fig.2 together with your answer sheets.)**

Gibbs Phase rule (10%)

4. (a)Check the degree of freedom at point A in Fig. 2(b) by using Gibbs phase rule, assuming that pressure is held at constant. (6%)
   (b)Explain the meaning of your result obtained in (a). (4%)

Eutectic phase diagram (25%)

5. The phase diagram of a hypothetical A-B alloy consisting of metal A and B is a eutectic diagram. The phase riched in A is an α phase and the phase riched in B is a β phase. The maximum solubility of element B in A at eutectic temperature is C_α=15 wt%. The eutectic composition is 50 wt% A and 50 wt% B.
   (a) Find the composition C_o of an A-B alloy which will make the alloy containing primary β mass fraction= 0.35 and total β mass fraction= 0.68. Also find the maximum solubility of element A in B C_β at eutectic temperature. (10%)
   (b) Draw schematically a eutectic diagram of this alloy. Assume that the melting temperature of element A is higher than B. Indicating all the known and in (a) solved compositions and all phases on the phase diagram. (7%)

5. Continued

(c) The microstructure of this alloy developed at temperature slightly lower than the eutectic temperature is shown in Fig.3. Answer the questions in Fig.3 with proper phase designations, for example: primary α, primary β, eutectic α, eutectic β or eutectic structure etc. (Note: not all above mentioned phases exist in the microstructure) (8%)**(Submit Fig.3 together with your answer sheets.)**

(9)

Fe-Fe_3C phase diagram and compositions (25%)

6. According to the Fe-Fe_3C phase diagram (You should have it plotted in your mind!), there is a carbon steel with a carbon content C%=0.82%.

(a) Determine the mass fraction of eutectoid ferrite $w_{\alpha\text{-eutectoid}}$. (6%)

(b) What kind of phase (name of the microstructure) will first develop on Austenite grain boundaries, i.e. what will be the **pro-eutectoid** phase of the steel when it is cooled from Austenite? (5%) $\gamma + Fe_3C$

(c) Determine the mass fraction of this **pro-eutectoid** phase in (b) at temperature slightly above eutectoid temperature T_E. (6%)

(d) Determine the mass fraction of total cementite $w_{\text{total cementite}}$. (6%)

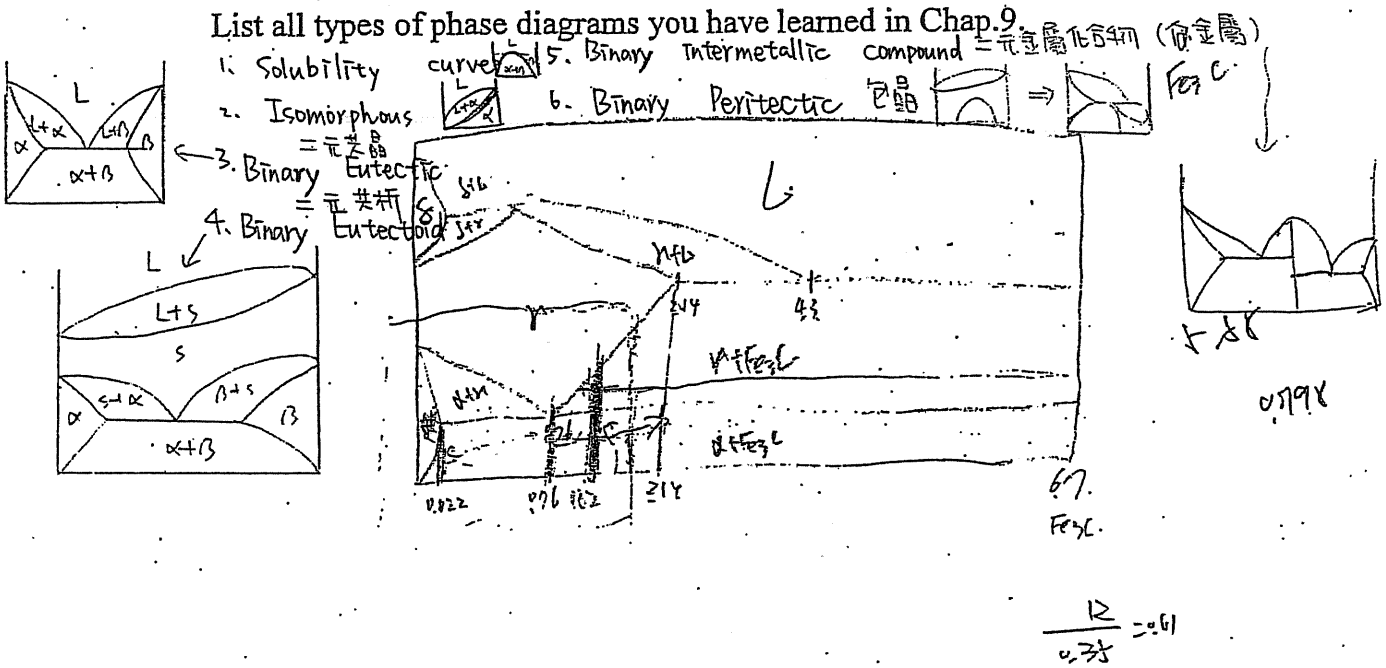
(e) Is this steel a hypo- or hyper-eutectoid steel? (2%) 過共析鋼

Metallography and microstructures (22%)

Give your answer on the attached sheet and submit fig. 4 together with your answer sheets.

Bonus (x %)

List all types of phase diagrams you have learned in Chap.9.



94 III

1. 固相內部濃 $\xrightarrow[\text{晶粒長大}]{\text{凝固}}$ 固相外部稀 濃度梯度

2.

3.

(a) 1080°C

(b) No

(c)

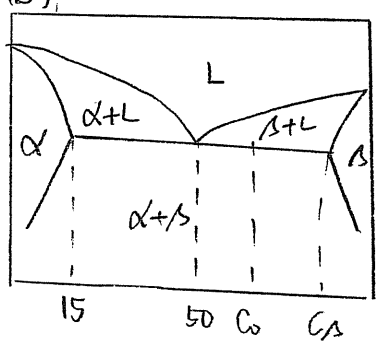
(d)

4.

$F = N + C - P$

5.

(b)



(a)

$C_\alpha = 15\ wt\%$

$W_\alpha' = 0.35 = \frac{C_0 - 0.5}{C_\beta - 0.5} \Rightarrow 0.35C_\beta - 0.175 = C_0 - 0.5$

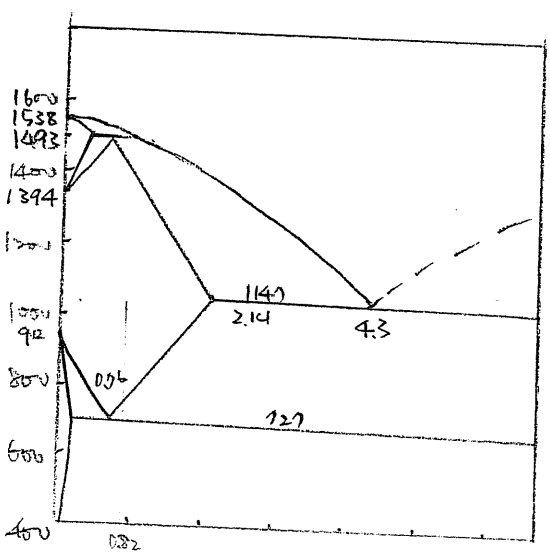
$W_\beta = 0.68 = \frac{C_0 - 0.15}{C_\beta - 0.15} \Rightarrow 0.68C_\beta - 0.102 = C_0 - 0.15$

$0.33C_\beta + 0.073 = 0.35$ $\quad C_\beta = \frac{0.277}{0.33} = 83.9\%$

$C_0 = 61.87\%$

(c)

6.



(a) $W_{\alpha\text{-}e} = 0.022\%$

(b) $Fe_3C + \gamma$

Fe_3C

(c) $W_P = \frac{6.7 - C'}{6.7 - 0.76}$

$W_{Fe_3C'} = \frac{C' - 0.76}{6.7 - 0.76}$

(d) $W_{Fe_3C^3} = \frac{C' - 0.022}{6.7 - 0.022}$

(e) hyper