96五

中正大學機械系 96 學年度上學期工程材料學期末考試題 97.1.15

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. Fig.1 shows a phase diagram for Cu and Ni.

(a) Draw schematically on the diagram 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 phenomena? (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 phenomena? (2%)

(d) What do we call this type of phase diagram? (2%) Do copper and nickel have limited or unlimited solubility to each other? (2%)

(e)If the alloy maintains at temperature c as shown in fig. 1, determine the wt% of solid phase α and wt% of liquid phase. (6%)

Make Drawing on sheet containing Fig.1 and submit this sheet together with your answer sheets.

2. **Pb-Sn phase diagram** is shown in fig. 2

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

(b) What is the meaning at points showing concentration wt% of 18.3%, 61.9% and 97.8%? (3%)

(b) If a **Pb-Sn** alloy contains 30% Sn, please draw schematically on Fig.2 to show how the microstructure develops as the alloy is cooled from liquid to solid. (6%)

(c) If a **Pb-Sn** alloy contains 30% Sn, what phase would first solidify from liquid? (2%)Determine the mass fraction of this pro-eutectic solid when the temperature almost reaches T_E. (5%)

(d) Continued from (c), if the temperature further decreases until it is slightly below T_E, what would happen to the rest of liquid? (2%)What are the concentration of the pro-eutectic solid and the concentration of the eutectic α and eutectic β? (6%)

(e) Determine the mass fraction of total α. (4%)

(f) If a **Pb-Sn** alloy contains 80% Sn, and the microstructure developed after complete solidification looks like fig. 2-1, what is the phase of the large dark regions? (2%)How much Sn% does this phase contain? (2%)

Make Drawing on sheet containing Fig.2 and submit it together with your answer sheets.

3. Show that the point E in the phase diagram in fig. 2 has a degree of freedom zero according to Gibb's phase rule. What does the degree of freedom zero mean? (6%)

4. Draw Fe-Fe_3C equilibrium phase diagram of ferrous alloys. Indicate (1) all phases, (2) temperatures and/or (4) wt.% of carbon at relevant points or lines. (18%)

The Fe-Fe_3C equilibrium phase diagram consists of three different phase diagrams. What are they? (6%)

Fe-Fe_3C phase diagram and compositions (17%)

5. 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%=0.80%.
   (a) Determine the mass fraction of eutectoid ferrite $W_{\alpha\text{-eutectoid}}$. (4%)
   (b) What kind of phase (name of the microstructure) will first develop from Austenite (or γ) grain boundaries when the steel is continuously cooled from higher temperature? i.e. what will be the **pro-eutectoid** phase when the steel is cooled from Austenite with a carbon content C%=0.80%? (3%)
   (c) Determine the mass fraction of this **pro-eutectoid** phase in (b) at temperature slightly above eutectoid temperature T_E. (4%)
   (d) Determine the mass fraction of **pearlite** (4%)
   (e) Is this steel a hypo- or hyper-eutectoid steel? (2%)

Metallography and microstructures (15%)

Fig. 6(a) corresponds to the microstructure of a carbon steel containing 0.35% carbon. ***Answer the questions with appropriate microstructure terminology.***

(1) What is the proeutectoid phase? The white grains or the the dark areas with bright and dark thin layers? How many wt% of carbon does the proeutectoid phase contain? (4%)

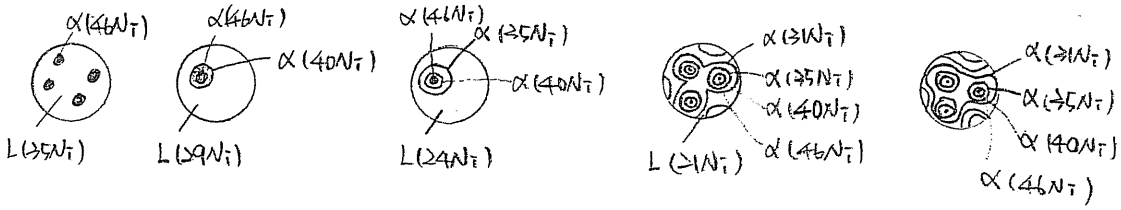
(2) What are the dark areas with bright and dark thin layers? How many wt % of carbon does the dark area in average contain? (5%)

(3) The dark area with bright and dark thin layers is magnified in fig. 6(b), what are the white layers and what are the dark layers? How many wt % of carbons does each contain? (6%)

91. II

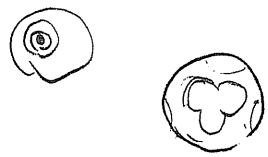
1.

(a) P.267



(b)

Segregation 偏析現象



(c) lower

過冷現象

(d) Isomophous diagram

limited

$(Ni)_\alpha = \frac{35-29}{40-29}$

$(Ni)_l = \frac{40-35}{40-29}$

(e) Cu - 35% Ni

$C_0 = 35$

$C_\alpha = 40$

$C_L = 29$

$(Ni)_\alpha = \frac{35-29}{40-29} = \frac{6}{11} = 54.55\%$

$(Ni)_L = \frac{40-35}{40-29} = \frac{5}{11} = 45.45\%$

2. P.271

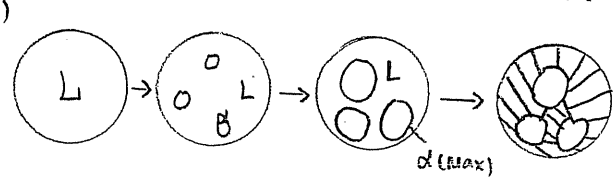
(a) Binary Eutectic diagram

(b) 18.3% → Rich Pb, Max Sn wt% could solute in Pb (Maximum solid solubility Compositions)

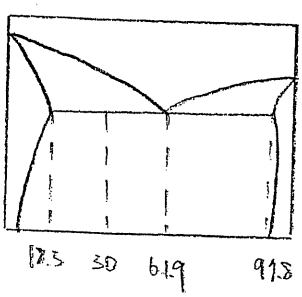
61.9% → Maximum solid solubility compositions

97.8% → Rich Sn, Max Pb wt% could solute in Sn

(c)



(d) α+L



$Wt\%\alpha' = \frac{61.9-30}{61.9-18.3} = 73.13\ Wt\%$

(e) 變成薄片狀 (lamellar)

pro-eutectic 18.3 Wt%

α' Wt% = 18.3 Wt%

β Wt% = 97.8 Wt%

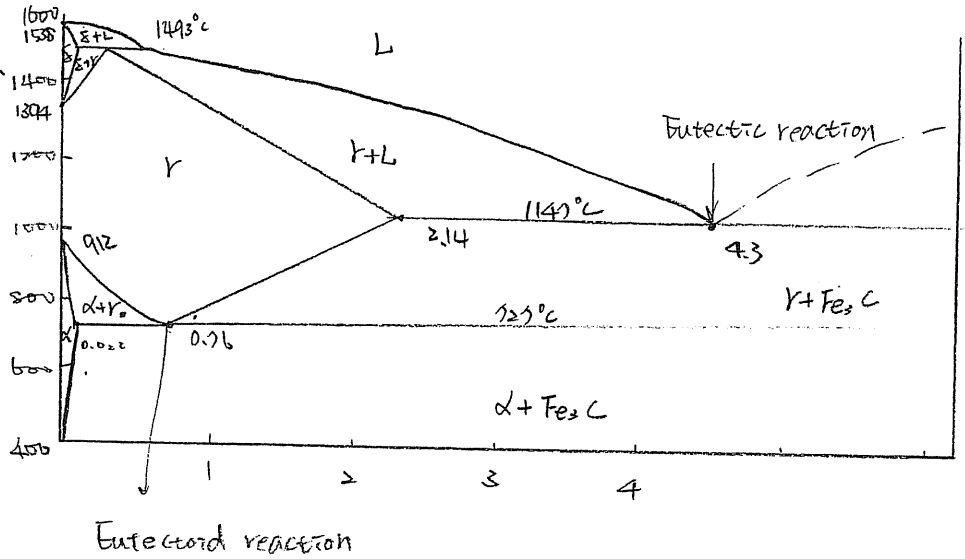
(f) $W_\alpha = \frac{97.8-30}{97.8-18.3} = 85.28\ Wt\%$

(g) α-phase

$W_\alpha = \frac{97.8-80}{97.8-18.3} = 22.39\ Wt\%$

3. $F = C-P+N = 0$ 0維一點

4.



Eutectoid reaction

α - Ferrite 一肥粒体 or 鉄素体

γ - austenite - 決新田鉄、奥氏体

δ - BCC same structure as α

5.

(a) $W_{\alpha\text{-eutectoid}} = \frac{6.7-0.8}{6.7-0.022} = 88.35\%$

(b) $Fe_3C + \gamma$

Fe_3C

(c) $W_{Fe_3C} = \frac{0.8-0.76}{6.7-0.76} = 0.67\%$

(d) $W_P = \frac{6.7-0.8}{6.7-0.76} = 99.33\%$

(e) hypereutectoid ※

6.

(1) before eutectoid T_e

$\alpha'\ Wt\% = \frac{0.76-0.35}{0.76-0.022} = 55.56\%$

(2) pearlite

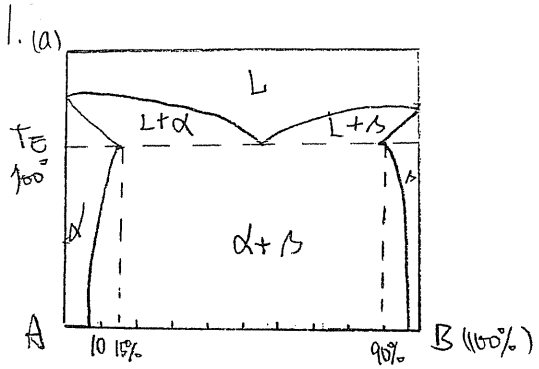
$W_P = 0.76\ Wt\%$

(3) Eutectoid α 0.022%

Eutectoid Fe_3C 6.7%

95.II

1. (a)

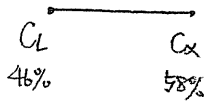


(b) Eutectic diagram

2. P.259

(a) Isomorphous phase : limited

(b)



(c) $C_0 = 50\%$
$C_L = 46\%$
$C_\alpha = 58\%$

$W_\alpha = \frac{50-46}{58-46} = 33.3\%$

$W_L = \frac{58-50}{58-46} = 66.7\%$

3. P.269

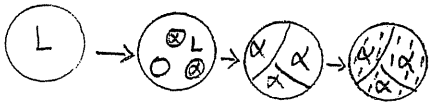
(a) Eutectic diagram

B : rich Cu, Max wt% Ag could solute in Cu

E : Maximum solid solubility compostetons

G : rich Ag, Max wt% Cu could solute in Ag

(b)



(c) α+L

$W_\alpha = \frac{91.9-40}{91.9-8} = 49.92\%$

(d) Eutectic structure

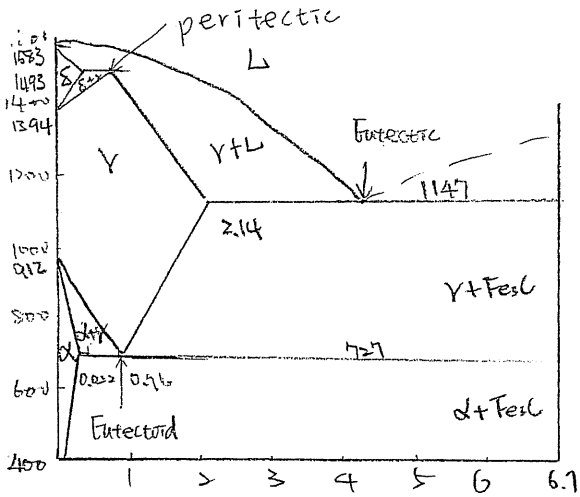
α 18.3 wt% Sn

β 97.8 wt% Sn

(e) $W_\alpha = \frac{91.2-40}{91.2-8} = 61.54\%$

$W_\beta = \frac{40-8}{91.2-8} = 38.46\%$

4.



5.

(a) $W_{\alpha e} = W_{\alpha} - W_{\alpha'} = \frac{6.7-0.4}{6.7-0.022} - \frac{0.76-0.4}{0.76-0.022} = 41.24\%$

(b) α+γ

γ

(c) $W_{\alpha'} = \frac{0.76-0.4}{0.76-0.022} = 48.78\%$

(d) $W_P = \frac{0.4-0.022}{6.7-0.022} = 5.66\%$

(e) hypo-eutectoid steel

7.

(1) proeutectoid α 0.022%

(2) pearlite 0.76%

(3) Eutectoid α 0.022%

Fe_3C 6.7%