جامعة بيرزيت
Birzeit University

Mechanical Engineering Departrment

Material Science (ENME 331)
Dr.Ibrahim Hammad

Final Exam 2006/2007
Time: 2 hours

St Name:________________ St Number:__________ Section:________

1. Define the following concepts (12 points /two points each)
   a. Annealing?
   b. Hall-Petch equation?
   c. TTT diagram?
   d. Stoichiometric intermetallic compound?
   e. Rate of phase transformation?
   f. Martensite steel?

10

2. Consider the fatigue test answer the following? (6 points)?
   a. Explain the fatigue test? (3points)
   b. What Results are obtained of the Fatigue Test (3points)?

5

3. Corrosion is a type of material degradation: explain the following (7points)?
   a. The mechanism of corrosion?(2 points)
   b. Types of corrosion? (3 points)
   c. Ways of preventions? (2 points) sacrifi

4. Given the Fe-Fe_3C phase diagram, Fig. 1, (20points)

Fatigue strength
limit
life

Department of Mechanical Engineering
ME 331 — Material Science

TEST 2

Please show your work.
Partial credit will be given if you set up a problem correctly.
No credit will be given for correct answers without supporting work.

1. Consider the fatigue test answer the following
   a. Explain the test?
   b. explain the stress characteristics of fatigue ?

2. Explain how to design a strain hardened specimen
3. The following data were collected from a 20 mm diameter test specimen of a ductile cast iron (l_o = 40.00 mm):

Load (N)	Gage Length (mm)	Stress (MPa)	Strain (mm/mm)
0	40.0000	0	0.0
25,000	40.0185	79.6	0.00046
50,000	40.0370	159.2	0.000925
75,000	40.0555	238.7	0.001388
90,000	40.20	286.5	0.005
105,000	40.60	334.2	0.015
120,000	41.56	382.0	0.039
131,000	44.00 (max load)	417.0	~~0.100~~ 0.1
125,000	47.52 (fracture)	397.9	0.188

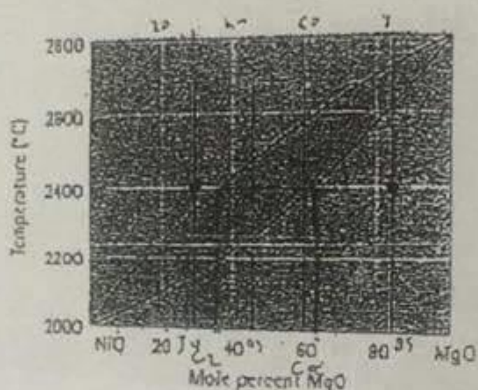
After fracture, the gage length is 47.42 mm and the diameter is 18.35 mm.
~~Plot the data and calculate~~
(a) The 0.2% offset yield strength,
(b) The tensile strength,
(c) The modulus of elasticity,
(d) The %Elongation,
(e) The %Reduction in area,
(f) The engineering stress at fracture,
(g) The true stress at fracture, and
(h) The modulus of resilience.

Good Luck

Mechanical Engineering Department
ENME 331
Dr.Ibrahim Hammad
Second

1. Determine the phases present, the compositions of each phase, and the amount of each phase in mol% for the following NiO–MgO ceramics at 2400°C. Answer the following:

(a) NiO–30 mol% MgO
(b) NiO–45 mol% MgO
(c) NiO–60 mol% MgO
(d) NiO–85 mol% MgO
(e) Microstructure development for (a,b,c,d) ?

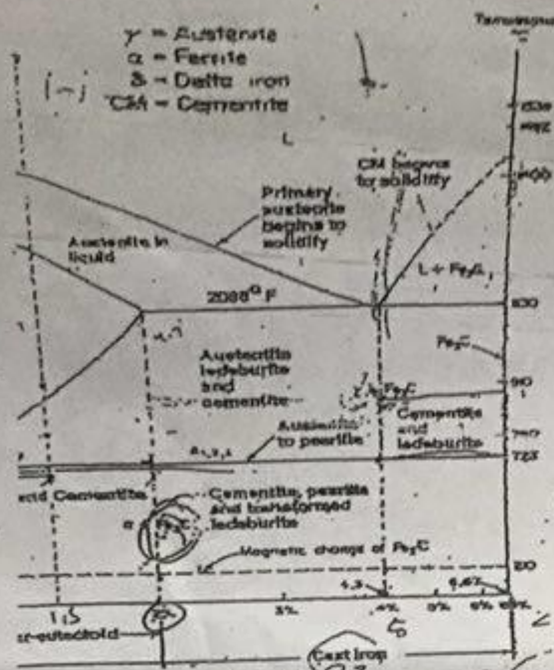


$w_L \sim \frac{C_\alpha - C_0}{C_\alpha - C_L}$

2. Explain the fatigue test? Then discuss the Results of the Fatigue Test? (use figures when necessary).

3. Define the following :
(a) Metastable state?
(b) Isomorphous system?
(c) Annealing?
(d) Frank read mechanism?

Good luck



$\alpha = \frac{0.02 - 0.83}{0.02 - 0.025}$ (6.67) $\alpha = 98.7$

ses present at the eutectoid composition line at: (6

(1 point) 100% L
(1 point) 100% Austenite
(2 points)
(2 points) 6

ases in the cast-iron portion of the diagram at the
on of 4.3%C in combination with 95.7% ferrite at:

(1 point) $\frac{6.76 - 0.83}{6.67 - 0.28}$
(2 points)
(2 points)

el (about 0.8%C) is heated to 800C (1472F) and
ough the eutectoid temperature. Calculate the
of carbide that form per 100g of steel. (3 points)

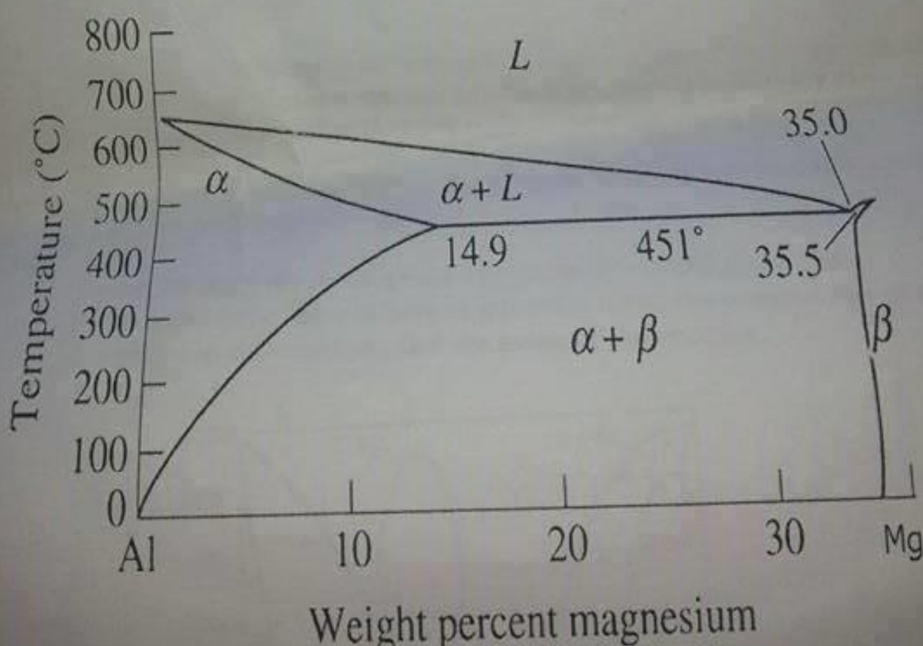
1.5

5) Suppose we introduce one carbon atom for every 100 iron atoms in an interstitial position in BCC iron, giving a lattice parameter of 0.2867 nm ,the iron atomic weight is 55.847 g/mol . For the Fe-C alloy, find
(10 points)

(a) The density and?
(b) The packing factor?

6) Consider an Al–12% Mg alloy see Figure. During solidification, determine:
(20 points)

(a) The composition of the first solid to form
(b) The liquidus temperature, solidus temperature, solvus temperature, and freezing range of the alloy,
(c) The amounts and compositions of each phase at 525°C
(d) The amounts and compositions of each phase at 450°C, and
(e) The amounts and compositions of each phase at 25°C.



Good luck

5

d. Determine the amount of pearlite in a 99.5% Fe-0.5%C alloy that is cooled slowly from 870C given a basis of 100g of alloy (2 points)

e. Show the microstructure at alloy B (2 points)

f. Name the reactions in the diagram (2points)

5. * The density of a sample of HCP beryllium is 1.844 g/cm3 and the lattice parameters are ao = 0.22858 nm and co = 0.35842 nm. the atomic weight is 9.01 g/mole Calculate: (5 points)

(a) How many atoms are in each unit cell?
(b) The packing factor.

(3.5842×10^{-8}) cm

$\rho = 1.844$ g/cm³

$a_0 = 0.22858$

$c_0 = 0.35842$ nm

9.01 g/mol

120

$a_0 = 2r$

$\boxed{a_0 = 2r}$

$c_0 = 1.633\, a_0$

$X = 1.997$

$\approx X = 2$

2) Bismuth has a hexagonal structure, with $a_o = 0.4546$ nm and $c_o = 1.186$ nm. The density is 9.808 g/cm3 and the atomic weight is 208.98 g/mol. Determine:

a) Find the packing factor?

b) The fraction of the lattice points that contain vacancies?

3) What are the types of defects and explain the surface defect?

G-D =

Good luck

$V_{hex} = a_0^2 \, C_0 \cos 30$

$\boxed{a_0^2 \, C_0 \cos}$

$a_0 = 0.4546$ nm , $C_0 = 1.186$ nm , $\rho = 9.808$

$W = 208.98$

$PF = \dfrac{(x)(\text{Volume of atom})}{\text{Volume of Unit Cell}}$

$\rho = \dfrac{(x)(\text{At. Weight})}{\text{Volume of Unit Cell}\,(6.023 \times 10^{23})}$

$x\,(\text{g/m}) \; (6.023 \times 10^{23}$

$\rightarrow x = \dfrac{9.808)(20\ldots}{(0.4546 \times 10^{\ldots}) \cos 30 \,(6.\ldots}$

$x = \dfrac{9.808\,(0.4546 \times 10^{\ldots}}{\cos\ldots}$

$x = 16.032$

$\dfrac{(\cancel{16.032}\;6)\left(\frac{4}{3}\pi r^3\right)}{(0.4546 \times 10^{-7})^2 (1.186 \times 10^{-7}) \cos 30}$

$a_0 = 2R$

$R = \dfrac{a_0}{2}$

$= \dfrac{\ldots}{2.9398 \times 10^{-22}}$

$R = 2.27\ldots$

Mechanical Engineering Department
ENM331
Final Exam
Dr. Ibrahim Hammad

Time: 2 hours May 28, 2013

Please show your work.
Partial credit will be given if you set up a problem correctly.
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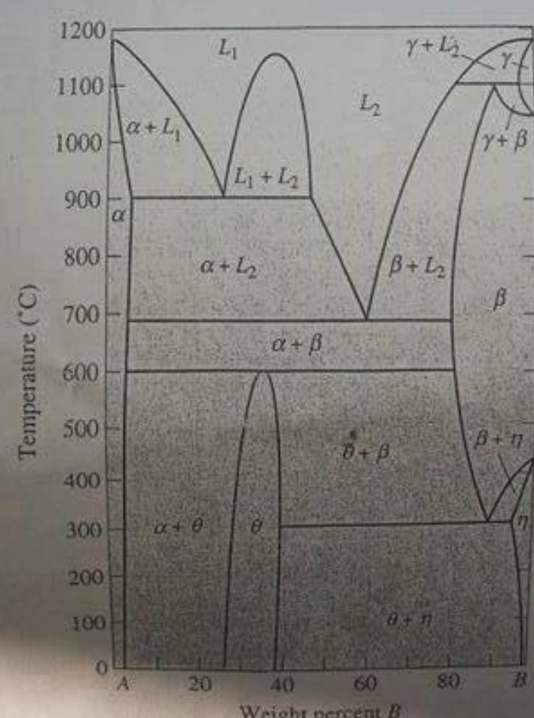
1. Answer the following (15 points)
   a. Describe strain hardening mechanisms?
   b. What are the three stages of annealing?
   c. Explain Heat-affected zone? (HAZ)

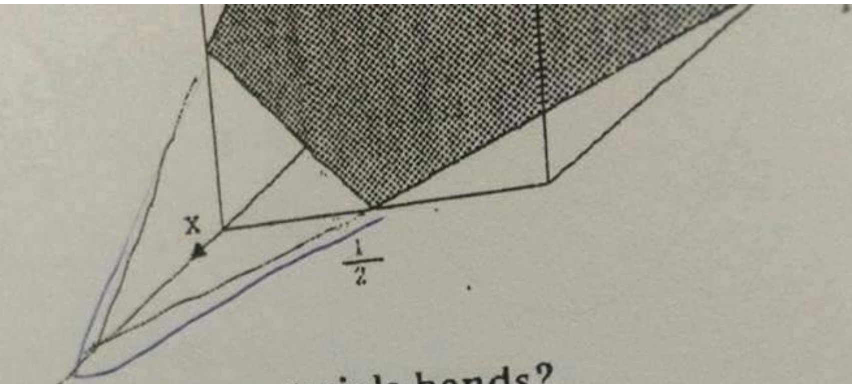
2) There are different types of material testing explain the following (15 points)
   a) Fatigue test ?
   b) Bending test?
   c) Rockwell test?

4) A hypothetical phase diagram is shown in Figure below *(15 points)*
   (a) Are any intermetalliccompounds present? *If so, identify them and* determine whether they are stoichiometric or nonstoichiometric.

   (b) Identify the solid solutions present in the system. Is either material *A* or *B* allotropic? Explain.

   (c) Identify the three-phase reactions by writing down the temperature, the reaction in equation form, the composition of each phase in the reaction, and the name of the reaction.





3) Mention and explain the materials bonds?

4) Explain the processing determines the defects?

1)The flexural modulus of alumina is 45×10^6 psi and its flexural strength is 46,000 psi. A bar of alumina 0.3 in. thick, 1.0 in. wide, and 10 in. long is placed on supports 7 in. apart. Determine

a) The force ?and
b) amount of deflection at the moment the bar breaks, assuming that no plastic deformation occurs.

2) FCC metal has a lattice parameter of 0.4949 nm and contains two vacancy per 1000 of the metal atoms. Calculate (a) the density and (b) the number of vacancies per gram of the metal. Atomic Weight=207.19 g/mol.

3 Describe

a) All types of Dislocations use figures?

b) Then use Schmid's Law to show the mechanism of *dislocation?*