

招生學年度	102	招生類別	碩士班
系所班別	材料科學與工程學系碩士班		
科目	材料科學與工程		
注意事項	本考科可使用掌上型計算機		

1. Please explain the following terms: (15%)

- (a) Segregation
- (b) Supercooling
- (c) Ductile-to-brittle transition
- (d) Intermetallic compound
- (f) Creep

2. A diffracted x-ray beam is observed from the (311) planes of aluminum at a 2θ angle of 78.3° when x-rays of 0.15418 nm wavelength are used.

- (a) Calculate the lattice parameter of the aluminum. (6%)
- (b) Determine the planar density and packing fraction for aluminum in the (100), (110), and (111) planes. (6%)

3. (a) How does the slip system inference the ductility of BCC, FCC, and HCP metals. (6%)
 (b) Please explain and sketch 12 slip systems for FCC? (6%)

4. (a) Please explain how dislocations, residual stresses, mechanical properties are involved in the recovery and recrystallization processes? (6%)
 (b) Why is it that recrystallization temperature is not fixed temperature for a given materials? (4%)
 (c) Why nanoscale oxide particles can inhibit the recovery and recrystallization processes and offer high creep strength in dispersion strengthened alloys (6%)

5. (a) Please explain how dislocations are involved in each of strengthening mechanisms in metals. (6%)
 (b) Which strengthening method is unaffected by heat treatment and explain why? (6%)

6. A 1015 steel is to be carburized at 1050°C for 2 h using a gas atmosphere that produces 1.2% C at the surface of the steel. (Please see the tables below for "diffusion data" and "error function")
 (a) Plot the percent carbon versus the distance ($x=0.03\text{cm}$, 0.05cm , 0.13cm , and 0.25cm) from the surface of the steel. (7%)
 (b) If the steel is slowly cooled after carburizing, determine the amount of each phase and microconstituent at 0.18 cm intervals from the surface. (8%)

Diffusion data for selected materials

Diffusion Couple	Q (cal/mol)	D_0 (cm^2/s)
Interstitial diffusion:		
C in FCC iron	32,900	0.23
C in BCC iron	20,900	0.011
N in FCC iron	34,600	0.0034
N in BCC iron	18,300	0.0047
H in FCC iron	10,300	0.0063
H in BCC iron	3,600	0.0012

Error function value for Fick's second law

Argument of the Error Function $\frac{x}{2\sqrt{Dt}}$	Value of the Error Function $\text{erf} \frac{x}{2\sqrt{Dt}}$
0	0
0.10	0.1125
0.20	0.2227
0.30	0.3286
0.40	0.4284
0.50	0.5205
0.60	0.6039
0.70	0.6778
0.80	0.7421
0.90	0.7969
1.00	0.8427
1.50	0.9661
2.00	0.9953

7. (a) In phase transformation mechanisms, please distinguishes homogeneous and heterogeneous nucleation by "critical free energy ΔG^* " (6%).
 (b) Please sketch the curves for nucleation rate, growth rate, and overall transformation rate versus temperature and describe the terms and their relationship (6%).
 (c) Please explain how the nucleation rate and growth rate inference the final grain size. (6%)