

## 科目：材料科學[2921]

1. (a) Write down the electron configuration for each of the following elements, (40%) using only their atomic numbers: Li ( $Z=3$ ), Al ( $Z=13$ ), Ti ( $Z=22$ ), Ni ( $Z=28$ ), Cu ( $Z=29$ )
- (b) Which of the following materials has the lowest free energy and why? (i) Fe, (ii)  $\text{Fe}^{3+}$ , and (iii)  $\text{Fe}_2\text{O}_3$
- (c) Consider atoms to be hard spheres in contact and calculate for body-centered-cubic packing, the following
- (i) the volume of the cubic unit cell in terms of an atom diameter  $D$
- (ii) the number of atoms per unit cell
- (iii) the density in terms of number of atoms/ $D^3$
- (d) A piece of metal (bcc) is exposed to an x-ray radiation with a wavelength of  $\lambda=0.154$  nm and a diffraction peak is observed at  $2\theta=44.7^\circ$  from the  $\{110\}$  plane, what is the lattice constant of the metal?
2. (a) A plastic material is stressed under a high stress of 1100 psi at  $20^\circ\text{C}$  for 40 (30%) days. When the stress is reduced to 700 psi at the constant strain, what is (i) the relaxation time constant, and (ii) the applied stress at the same temperature ( $20^\circ\text{C}$ ) for 60 days?
- (b) If it takes 0.5 h to soften a metallic alloy to 172 MPa at  $230^\circ\text{C}$  and 100 h at  $190^\circ\text{C}$  to reach the same strength, what is the activation energy for the process in kilojoules per mole? Given: gas constant,  $R=8.314$  J/mol-deg
- (c) Consider a unit slip dislocation with a Burgers vector  $\frac{a}{2}[\bar{1}10]$  on a (111) plane in a face-centered-cubic crystal, (i) what is the direction of the dislocation line, and (ii) how does the dislocation line ( $\frac{a}{2}[\bar{1}10]$ ) split into two partial dislocations?
3. Explain the following definitions
- (30%)(a) Dendrite: (f) Carbon nanotube:
- (b) Martensite: (g) Etch pit:
- (c) Phase rule: (h) Eutectoid reaction:
- (d)  $p$ -type semiconductor: (i) Transistor:
- (e) Fermi level: (j) Curie temperature: