

1. True and Fault (10%)

- (a) The stress required for the dislocation slip is theoretical shear stress. (2%)
- (b) There are generally twelve slip systems in body-centered cubic crystal. (2%)
- (c) Interaction between two perpendicular screw dislocations must generate a kind of edge dislocation in face-centered cubic crystal. (2%)
- (d) Crystal with low stacking fault energy has enhanced cross-slip. (2%)
- (e) Dislocation climb is a conservative motion. (2%)

2. Metallurgy (10%)

Figure 1 shows an Al-Ni binary phase diagram without phase marks. Please answer the following questions:

- (a) Propose a proper alloy composition and production process to easily pull out a single crystal under a very slow cooling rate. (5%)
- (b) Draw the microstructural evolution of Al80-Ni20 alloy (in wt.%) in non-equilibrium cooling from 1000 °C to 400 °C. (5%)

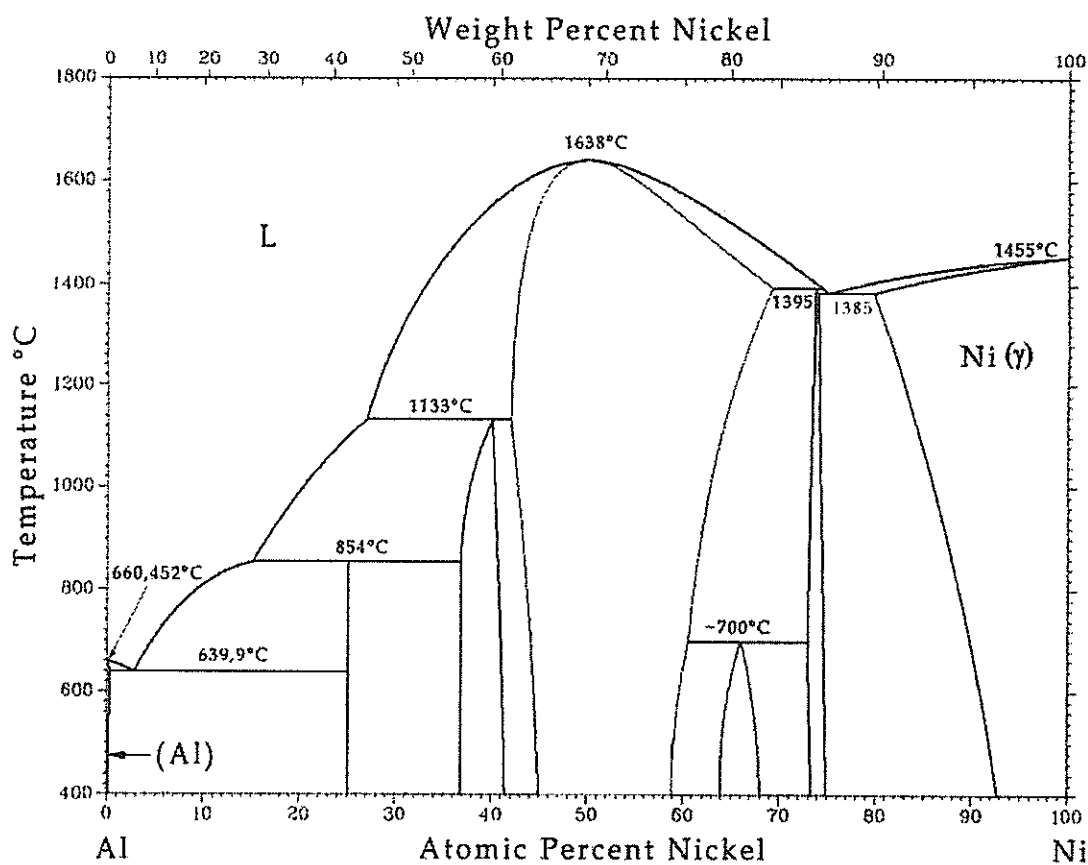


Figure 1 The Al-Ni binary phase diagram

3. Theory of Metals (10%)

Principle: *Increasing yield strength of metals without enhancement of work hardening rate always leads to worse uniform elongation.* Please prove this principle. (10%)

4. Characterizations (10%)

Figure 2 shows a series of X-ray diffraction spectrum from a steel under tensile test at different engineering strain (ϵ_E). The source of X-ray used here is $\text{CuK}\alpha \sim 0.1542 \text{ nm}$. The peak positions from ϵ phase, which is a hcp phase, have been marked. Please answer the following questions:

- (a) What are other phases in this steel in these experiments? Please identify their possible crystal structures and lattice constants. (8%)
- (b) Please describe what happen to this steel under tensile test. (2%)

見背面

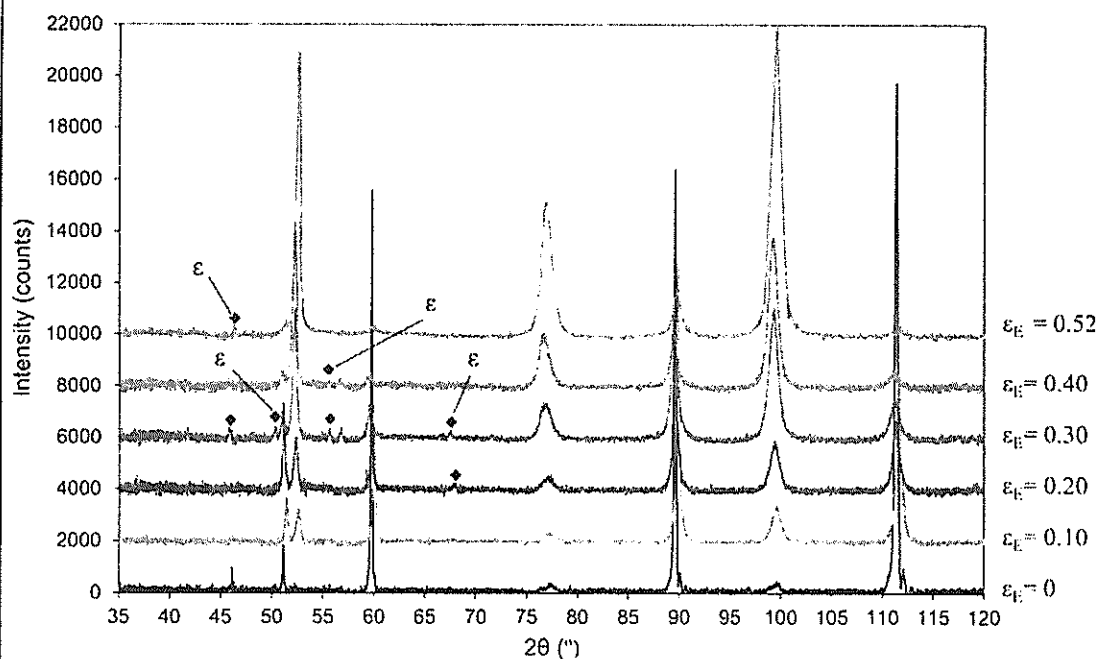


Figure 2 A series of X-ray diffraction spectrum from a steel under tensile test at different engineering strain

5. Of poly(methyl methacrylate) (PMMA), polypropylene, and poly(hexamethylene adipamide) (Nylon 6,6), which polymer would be best suited for use as ice cube trays? Why? (10%)
6. Sketch chemical structures for isotactic polystyrene and atactic polystyrene. (4%) Which one would be a semicrystalline polymer? Why? (6%)
7. Give an example of a ceramic material which is brittle but high in Weibull modulus. Explain your answer in details including the macro and micro properties of the ceramic material you have chosen. (10%)
8. There are some ceramic structures which are easier to be described by the packing of cations. For example, cubic phase ZrO_2 is characterized by an FCC packing of Zr^{4+} . Based on the above information, how many O^{2-} ions are needed to fill in what interstitial sites in order to produce cubic ZrO_2 ? Explain your answer. (10%)
9. What is a (i) silicon (Si) based solar cell? (ii) perovskite solar cell? Please describe the operation of the two types of solar cells. Please also compare the advantages and disadvantages of silicon and perovskite solar cells. (12%)
10. For each of the following pairs of semiconductors, decide which will have the smaller band gap energy, E_g , and then describe the reason for your choice. (i) ZnS and CdSe, (ii) Si and C (diamond), (iii) Al_2O_3 and ZnTe, and (iv) GaAs and AlP. (8%)

試題隨卷繳回