

第一大題（複選題，每題 10 分，各題答案全對才給分）

- The powder pattern of an element contains first five lines whose $\sin \theta$ values are 0.334, 0.3856, 0.542, 0.6348 and 0.6626. The wavelength of incident X-ray is 1.54 Å and it has a cubic structure. Please choose the correct statement(s):
 - the element has a simple cubic structure,
 - the element has a body centered cubic structure,
 - the lattice constant of the element is 4.0 Å,
 - the index of the fifth line, $\sin \theta = 0.6626$, is (222).
- Please choose the correct statement(s):
 - The magnitude of the shear associated with a twin in a body-centered cubic crystal is 0.707.
 - Dynamic recovery occurs most strongly in metals of high stacking-fault energies and is not readily observed in metals of very low stacking-fault energy.
 - Kink and jog are two basic steps formed by dislocation intersections. The step of kink is normal to the slip plane of dislocation, but the step of jog lies in the slip plane of dislocation.
 - For the interaction of dislocations with aged particles, it is more difficult to move the second dislocation than the first one through the non-deformable particle, but not for the deformable particle.

第二大題（問答題，請依題號順序作答）

- Demonstrate the Johnson and Gilman mechanism which explain the phenomenon of yield point. (10%)
- Describe the development of a cup-and-cone fracture in a tensile specimen, including the void-sheet mechanism. (14%)
- Explain the following:
 - Divorced eutectic. (7%)
 - Bauschinger effect. (7%)
- Why does a crystal growing in a liquid tend to develop faces that are slow-growing (close-packed)? (7%)
 - Draw the free energy of a droplet of liquid as a function of its radius, and discuss briefly the effects of undercooling on the critical nucleus size, r^* . (7%)
- For the precipitation in aluminum-4% copper alloy:
 - Draw the curves of hardness versus aging time for this alloy aged at room temperature, 130°C and 190°C, respectively. (5%)
 - Compare and discuss briefly these three hardness curves. (4%)
 - How can you achieve an extra-high hardness in a short aging time for this alloy? Why? (5%)
- Figure 1 shows the phase diagram of Ti-Al:
 - What are the structures of α Ti and β Ti? (4%)
 - Please discuss the characteristics of superlattice structure? (5%)
 - Why are the non-stoichiometric compounds harder than the stoichiometric ones at low temperature? (5%)

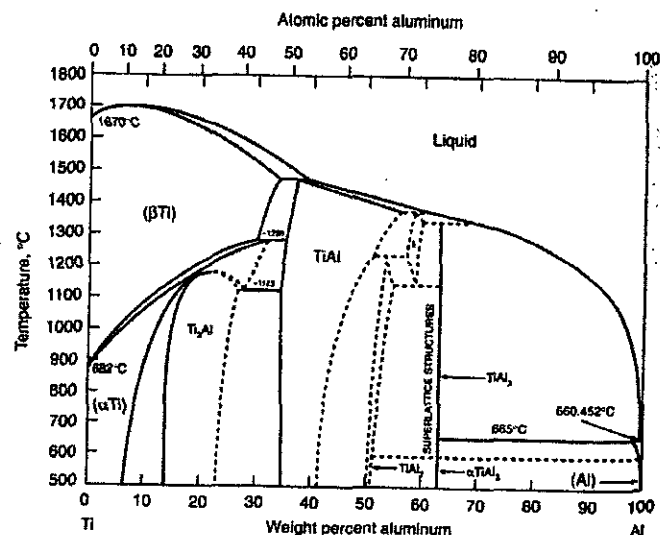


Figure 1