

1. Writing (15%)

Please briefly introduce to new materials for electrical vehicle, compared with combustion-engine vehicle. This introduction should be written in English with 150 – 200 words. (15%)

2. Metallurgy (15%)

- (1) Explain the mechanism for stainless steel to prevent corrosion. (5%)
- (2) Explain the reason for ductile-to-brittle transition temperature (DBTT) in low-carbon steel. (5%)
- (3) Derive the condition of plastic instability based on a tensile stress-strain curve. (5%)

3. Oxides (10%)

- (1) Sketch the difference in crystal structure between Fe_2O_3 and Fe_3O_4 . (4%)
- (2) Figure 1 shows bandgaps and dielectric constants of various materials. Comparing HfO_2 and TiO_2 , which one can be ideal High-K materials? Why? (6%)

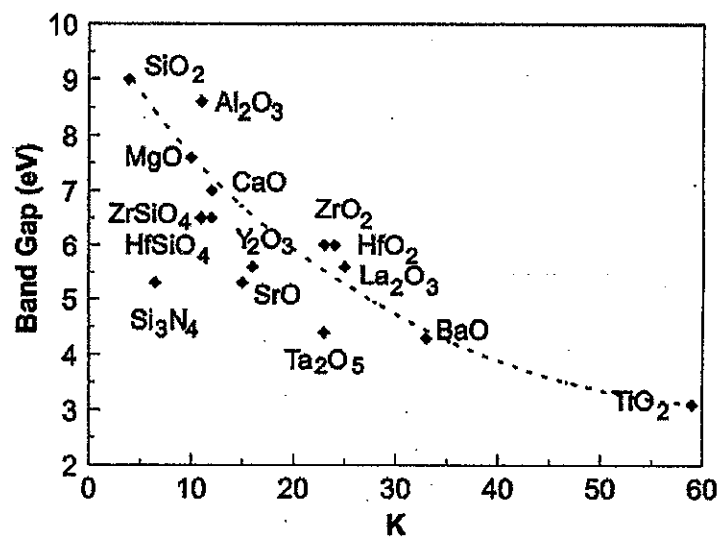


Figure 1 Bandgaps vs dielectric constants of various materials

4. Semiconductor (10%)

What are the major compound semiconductors? Please summarize their importance and features.

5. Phase Diagram (15%)

Please answer to the following questions based on the Ti-Al phase diagram in Figure 2.

- (1) List all eutectoid points from Figure 2. (5%)
- (2) For $Ti_{2.9}Al$ and $TiAl_{2.9}$, which one is relative stable? (3%)
- (3) Ti-45Al (in at. %) alloy was homogenized at 1350 °C for 12 and, then, cooled to 600 °C under a non-equilibrium cooling. Draw the microstructural evolution step-by-step in cooling. (7%)

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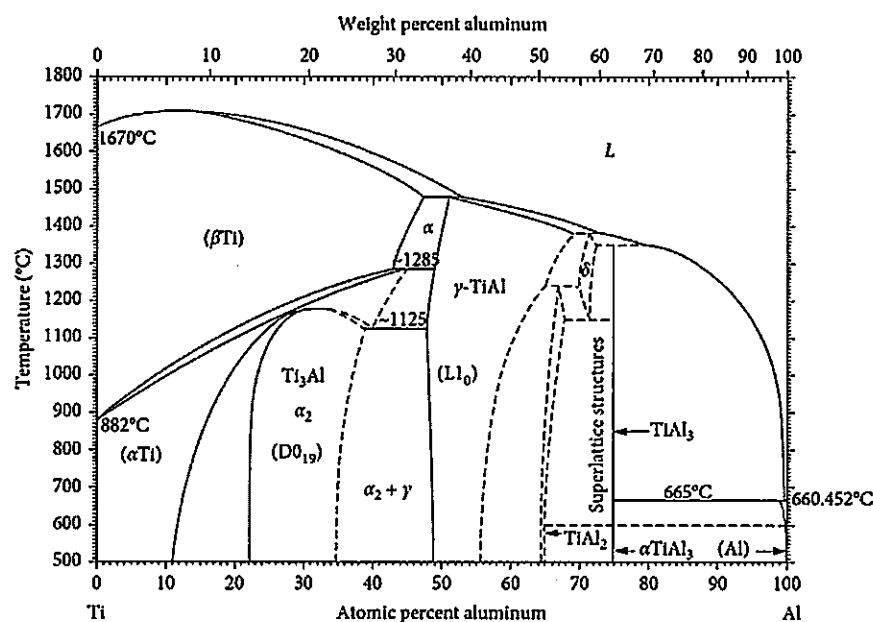


Figure 2 Ti-Al binary phase diagram

6. Structure (10%)

- (1) List common slip systems of pure copper. (4%)
- (2) If the perfect dislocation in copper dissociate into Shockley partial dislocations, please write down the dissociation reaction. (3%)
- (3) Provide on mechanism in which the dislocation dissociation enables the formation of mechanical twin in copper. (3%)

7. Polymer (18%)

Please explain the following term:

- (1) Branched polymer (3%);
- (2) Thermosetting resins (3%);
- (3) Polymer blends (3%);
- (4) Atactic, syndiotactic and isotactic polystyrene (9%).

8. Mechanical Property (7%)

Please comment on the following statement:

"Grain refinement makes polycrystalline copper stronger, tougher and more ductile".

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