1. Please judge the following statements as "True" or "False". (27%, 3% for each)
   (1) Intermetallic compound is formed by ionic bonding.
   (2) General materials with stronger bonding energies have larger Young's moduli.
   (3) Triclinic crystal and hexagonal crystal systems belong to hexagonal crystal family.
   (4) Burgers vector of an edge dislocation is parallel to its line vector.
   (5) Boundary between hetero-phase crystals is called grain boundary.
   (6) Plastic deformation is permanent deformation.
   (7) The Gibbs phase rule $P + N = C + 2$ gives the relationship between the number of phases P and components C in a given alloy under equilibrium conditions at constant pressure, where N is the number of thermodynamic degrees of freedom in the system.
   (8) Solute diffusivity in body-centered cubic (BCC) iron is larger than that in face-centered cubic (FCC) iron.
   (9) High-entropy alloy is a novel alloy following the Hume-Rothery rule.

2. Intrinsic resistivity of Ge is 47 Ω.cm at 300 K. What is intrinsic carrier concentration of Ge when its mobilities of electron and hole are 3900 $cm^2/V.s$ and 1900 $cm^2/V.s$, respectively. (8%)

3. What is Fick's second law? Please give the answer with related equation and description. (8%)

4. What are strengthening mechanisms in ductile materials? (12%)

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5. Sketch chemical structures of (1) PVC, (2) PP, (3) PTFE PMMA, (4) PET, and (5) Nylon 6. Hint: Must show all elements, including C and H. (15%, 3% for each)

6. Figure 1 shows Fe-Ti binary phase diagram. Please answer the following questions. Hint: Consider all dashed lines as solid lines in the phase diagram. (15%)
   (1) Please list all eutectic points with temperature and compositions (roughly). (4%)
   (2) Please draw the microstructure evolution of Ti-40%Fe (in at. %) alloy which undergoes equilibrium cooling from 1600 °C to 300 °C. (5%)
   (3) Design a Fe_2Ti-based superalloy with detailed composition, related process and final microstructure of the alloy. (6%)

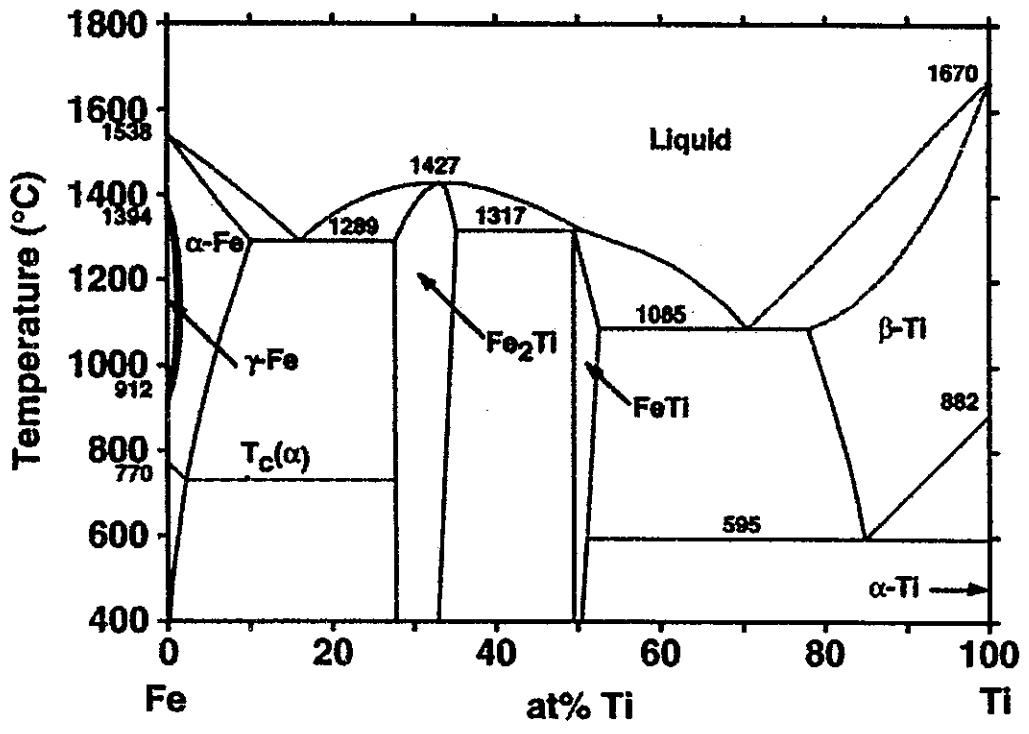

Figure 1 Fe-Ti binary phase diagram

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7. Sketch crystal structures of (1) tetragonal and (2) ferroelectric HfO_2. Please clearly mark all atoms and crystal family. (6%, 3% for each)

8. Please briefly explain the following abbreviations in materials science and technology: (1) MOF, (2) APT and (3) EUV. (9%, 3% for each)

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