재료공학개론 (400.020.001)

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Midterm Exam

1.(10 points) (a)(5 points) The coordination number (CN) in ionic crystals can be determined by the radius ratio. Explain the dependence of CN on radius ratio.

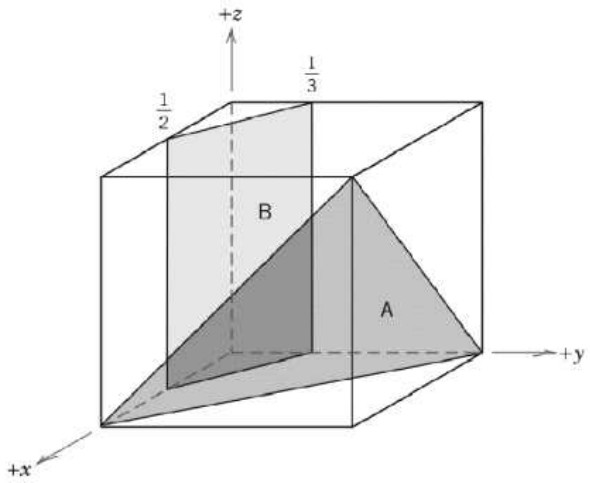
(b)(5 points) Explain why hydrogen fluoride (HF) has a higher boiling temperature than hydrogen chloride (HCl) (19.4 vs. -85°C), even though HF has a lower molecular weight.

2.(10 points) The physical properties of materials strongly depend on the exact shape of the energy well (potential well). Draw the typical energy well and explain the elastic, thermal, and other properties in terms of the energy well characteristics.

3.(10 points) (a)(5 points) What is a lattice?

(b)(5 points) Describe how face-centered cubic and hexagonal close packed crystal structure may be generated by stacking the close-packed planes of atoms.

4.(10 points) Determine the Miller indices for the planes shown in the following unit cell.



5. (a)(5 points) What is a Burgers vector?
(b)(5 points) Why do Burgers vector usually lie in closest-packed directions and why are the close packed planes usually the slip planes?

6.(10 points) Figure 6.22 shows the tensile engineering stress - strain behavior for a steel alloy.

(a) What is the modulus of elasticity?

(b) What is the proportional limit?

(c) What is the yield strength at a strain offset of 0.002?

(d) What is the tensile strength?

(e) What is the approximate ductility in percent elongation

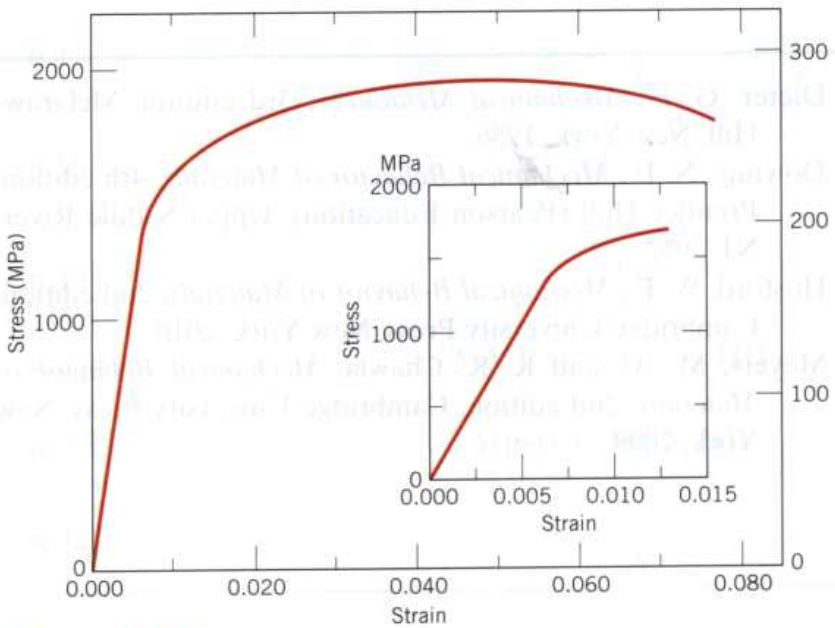


Figure 6.22 Tensile stress–strain behavior for an alloy steel.

7.(10 points) Point defects such as vacancies and interstitials are thermodynamically stable and it is impossible to create a stable crystal without point defects at finite temperature. Explain the reason for that the point defects are thermodynamically stable.

8.(10 points) (a)(5 points) Describe the conditions for substitutional solid solution.
(b)(5 points) What is the reason for the higher diffusion coefficient (or diffusivity) of several elements (Fe, C, Cr, etc) in BCC-Fe than FCC-Fe at the same temperature?

9.(10 points) The plastic deformation in metals occurs by the movement of dislocation. Based on this concept, discuss the four strengthening mechanisms in metals.

10.(10 points) (a)(5 points) What are the three stages of annealing process of cold worked samples. Describe the microstructural changes at each stage.
(b)(5 points) Draw the dependence of tensile strength and ductility on the annealing temperature.