Solid State Physics- SSP

Crystal Imperfections (T-Sheet 2) M.A.Shah

1. The energy required to create a lattice vacancy in a crystal is equal to 1 eV. The ratio of the number densities of vacancies *n* (1200 K)/*n* (300 K) when the crystal is at equilibriumat 1200 K and 300 K, respectively, is approximately?

2. Sodium Chloride NaCl crystal is a face-centered cubic lattice with a basis consisting of Na^- and Cl^- ions separated by half the body diagonal of a unit cube. Which of the planes corresponding to the Miller indices given below will not give rise to Bragg reflection of *X* -rays?

   a)100 b) 201 c) 200 d) 211

3. The total energy of an ionic solid is given by an expression $E = -\frac{\alpha e^2}{4\pi\varepsilon_0 r} + \frac{B}{r^9}$, where α is Madelung constant, *r* is the distance between the nearest neighbors in the crystal and *B* is a constant. If r_0 is the equilibrium separation between the nearest neighbors then the value of *B* is?

4. To get n-type doped semiconductor, the impurity to be added to silicon should have the following number of valence electrons?

5. A single crystal of copper contains low angle title boundary on (001) plane with a tilt axis parallel to [010]. Cal the tilt angle if the spacing of dislocation in the boundary is 3 x 10^{-6} m and their burger vector is 0.4 x 10^{-9} m.

6. A compound is formed by two elements X and Y. Atoms of the element Y (as anions) make ccp and those of the element X (as cations) occupy all the octahedral voids. The formula of the compound is?

7. A solid $A^+ B^-$ has the B ions arranged in BCC. If the A^+ ions occupy half of the octahedral sites in the structure. The formula of solid is

8. Burgers vector is a measure of the lattice distortion due to the presence of which imperfection?

9. Determine the fraction of atoms in a given solid with the energy equal to or greater than 1.5 eV at room temperature 300K at 1500K.

10. A copper crystal has a dislocation density of 1×10^{13} m^{-2}. The shear modulus of copper is 44 N/m^2. Calculate the elastic energy of line imperfection stored in the crystal.

11. In a simple cubic crystal (a= 3A), a positive edge dislocation 1 mm long climbs down by 1 micrometer. How many vacancies are lost?

12. The density of Schottky defects in a certain sample of sodium chloride is 5 x 10^{11} cm^3 at 300K. If the inter ionic separation is 2.82 A, what is the average energy required to create one schottky defect.

13. A strip of iron of dimension 1x2x15 cm is bent into a radius of curvature of 12 cm. What is the dislocation density [111] edge dislocation line up with their Burgers vector along the strip?

14. The energy of formation of a vacancy in copper is 1ev. Estimate the relative change in the density of copper due to vacancy formation at a temperature just below its melting point 1356K.

15. The energy required to remove a pair of ions, Na^+ and Cl^-, from NaCl is 2ev. Calculate the number of Schottky imperfections present in the NaCl crystal at 300K.