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1. In an FCC lattice, the largest interstitial voids occur at positions like (½, 0, 0), (0, ½, 0), (0,0, ½) etc. γ-iron crystallizes in FCC structure. Find atomic radius of the largest interstitial void in γ-iron.

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Ans1. In FCC lattice: voids = Tetrahedral voids

= Octahedral voids

The radius of largest interstitial void (octahedral void) is

$R = 0.414r$

Where radius of γ-iron crystallizes in FCC structure is $1.292\ A^o$

$R = 0.414 \times 1.292\ A^o$

$= 0.534\ A^o$

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2. An optical microscope can resolve a step of aluminum width 300 nm. A slip band was observed in a simple cubic crystal (a = 3 Å). How many (minimum) dislocations must have slipped out of the crystal?

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Ans 2. Width of slip band, w = 300 nm

lattice parameter, a = 3 Å

No. of dislocations have slipped out of the crystal =

(Width of slip band - No. of dislocations) / No. of dislocations

= (3000 -3)/3 Å

= 999 Å

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3. Does the burger vector change with the size of the burger circuit? Explain.

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Ans 3. No, it depends on no. of dislocation not on the circuit.

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4. Distinguish between the direction of the dislocation line, the burgers vector and the direction of motion for both the edge and screw dislocations. Differentiating between positive and negative types.

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- An *edge* dislocation has its Burgers vector perpendicular to the dislocation line. A *screw* dislocation, the Burgers vector is parallel to the dislocation line.
- For an edge dislocation, the Burgers vector is parallel to dislocation motion. For a screw dislocation, the Burgers vector is parallel to the dislocation. The Burgers vector is always parallel to slip.
- During **positive** climb, the crystal shrinks in the direction perpendicular to the extra half plane of atoms because atoms are being removed from the half plane. Since **negative** climb involves an addition of atoms to the half plane, the crystal grows in the direction perpendicular to the half plane.

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5. An aluminum crystal has a dislocation density of 10^{10} m^{-2}. The sheer modulus of aluminum is 25.94 GNm^{-2}. Calculate the elastic energy of line imperfections stored in the crystal.

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Ans 5. Density of aluminum crystal, $\rho = 10^{10}\ m^{-2}$

Sheer modulus of aluminum is $\mu = 25.94\ GNm^{-2}$

$E = ?$

$\rho = 1/l^2$, length of dislocation line

sheer stress = $\mu b/l$

For perfect crystal, sheer stress = $\mu/6$

$b/l = 1/6$

$b = l/6 = 1.67\ \mu m$

$E = \mu b^2/2$

$= 36.17\ J/m$

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- 6.Average energy required to create Frenkel defect in an ionic crystal is 1.4 eV. Calculate the ratio of Frenkel defects at 20°C and 300°C in 1gram of crystal.

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- Ans6. For ionic crystal, no. of point imperfections

n= N exp(-ΔHf/2RT)

Where Hf is enthalpy of formation of one mole of each of cation=anion

R= $8.62*10^{-5}$ evk

N= Avagadro No.

Hf=1.4ev

n1/n2 = exp(-ΔHf/2RT1)/exp(-ΔHf/2RT2)

=exp(-ΔHf/2R(1/T1-1/T2) = 1.65×10^{-4}