Thapar Institute of Engineering and Technology
School of Physics and Materials Science
Engineering Materials (UES012)
ODD Semester 2023 - 24 (July – Dec 2023)

Tutorial Sheet No. 4

1. All C-C bonds in the graphite layer are 1.42 Å, and the distance between layers is 3.44 Å. Calculate the density of graphite.
2. Zn has HCP structure, and height of the unit cell is 4.94 Å, atomic wt. of Zn is 65.37 gm/mole. Calculate the volume of the unit cell and the density of Zn.
3. NaCl has the FCC lattice with a = 5.63 Å. What is the spacing of {100} plane?
4. A BCC crystal is used to measure the wavelength of some X-rays. The Bragg angle for reflection from the (110) plane is θ =20.2°. What is the wavelength? The lattice parameter of the crystal is 0.315 nm.
5. In powder diffraction pattern for Lead (FCC) with radiation of λ = 1.54 Å the (220) Bragg reflection angle is θ = 32°. What is the radius of the atom?
6. From an X-Ray powder diffraction of a pure element, peaks at the following 2θ values in degrees were obtained 38.7, 45.4, 65.7, 78.8, 83.0, 99.6, 112.5, 117.0, 138.1, and 164.2. Copper K_α (λ = 1.54 Å) radiation was used. Identify the element.
7. Ti undergoes a phase change from BCC to HCP at 880°C on cooling. Calculate the percentage change in the volume. Given lattice parameter a_{BCC} = 3.32 Å, a_{HCP} = 2.956 Å, c = 4.683 Å.
8. Find the diameter of the largest atom that would fit an interstitial void in FCC Nickel (a = 0.353 nm) without distortion.
9. Find the size of the largest sphere that will fit an interstitial void in a BCC crystal as a function of the atomic radius r. The void is located at (0, ½, ¼) and equivalent positions.
10. For the LiF crystal (r_{Li^+} = 0.076 nm r_{F^-} = 0.133 nm) determine the following
    a) Structure and co-ordination number
    b) Show (100) planes and find out the planar density
    c) Lattice type and total ionic packing fraction
    d) Density of the unit cell

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Tutorial Sheet No. 5

1. Does the burger vector change with the size of the burger circuit? Explain.
2. Distinguish between the direction of the dislocation line, the burgers vector and the direction of motion for both the edge and screw dislocations. Differentiate between positive and negative dislocations.
3. Calculate the activation energy for vacancy formation (in eV) in aluminum, given that the equilibrium number of vacancies at 500 °C is 7.57×10^{23} m^{-3}. The atomic weight and density of aluminum are, 26.98 g/mol and 2.62 $g/cm^{3,}$ respectively,
4. Lead (FCC) has a lattice parameter of 0.4949 nm and contains one vacancy per 500 Pb atoms. Calculate (a) the density and (b) the number of vacancies per gram of Pb.
5. Average energy required to create a Frenkel defect in an ionic crystal is 1.4 eV. Calculate the ratio of Frenkel defects at 20°C and 300°C in 1 gram of a crystal.
6. An FCC Palladium crystal has a lattice constant of 0.389 nm. The sheer modulus of Palladium is 42 GNm^{-2}. Calculate the elastic energy of line imperfections stored in the crystal.
5. The small angle boundary in FCC copper is due to extra (100) planes of atoms as edge dislocations. If the disorientation angle is 1°, what is the distance between two neighboring edge dislocations? Given lattice parameter for Cu = 3.62 Å.
6. Calculate the spacing between dislocation in a low-angle tilt boundary in Iridium (FCC) when the angles of tilts are 1° and 3°. The lattice constant of Ir is 3.84 Å.
7. For reduction reaction, the electrode potential of pairs Al-Cu (−1.662 eV - +0.34 eV) and Fe-Cr are (+0.771 eV - −0.744 eV), respectively. Amongst these pairs, which is more prone to corrosion? For that pair, which element will act as an anode and cathode?