3-32 Determine the planar density and packing fraction for FCC nickel i
(100), (110), and (111) planes. Which, if any, of these planes is close
packed?

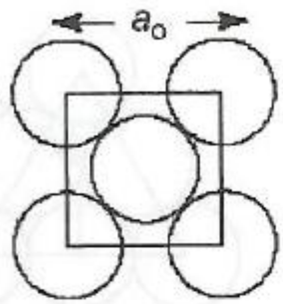
Solution:

$a_o = 3.5167$ Å

For (100):

$$\text{planar density} = \frac{2}{(3.5167 \times 10^{-8}\ \text{cm})^2} = 0.1617 \times 10^{-16}\ \text{points/cm}^2$$

$$\text{packing fraction} = \frac{2(\pi r^2)}{(4r/\sqrt{2})^2} = 0.7854$$

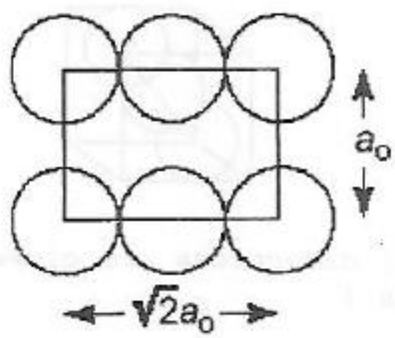


For (110):

$$\text{planar density} = \frac{2\ \text{points}}{(3.5167 \times 10^{-8}\ \text{cm})(\sqrt{2})(3.5167 \times 10^{-8}\ \text{cm})}$$

$$= 0.1144 \times 10^{16}\ \text{points/cm}^2$$

$$\text{packing fraction} = \frac{2(\pi r^2)}{\sqrt{2}(4r/\sqrt{2})^2} = 0.555$$



For (111):

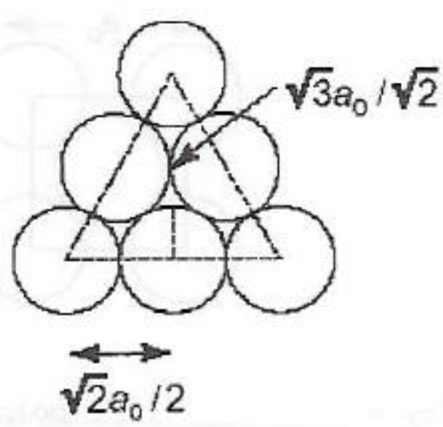
From the sketch, we can determine that the area of the (111) plane is $(\sqrt{2}a_o/2)(\sqrt{3}a_o/\sqrt{2}) = 0.866a_o^2$. There are $(3)(1/2) + (3)(1/6) = 2$ atoms in this area.

$$\text{planar density} = \frac{2 \text{ points}}{0.866(3.5167 \times 10^{-8} \text{ cm})^2}$$

$$= 0.1867 \times 10^{-16} \text{ points/cm}^2$$

$$\text{packing fraction} = \frac{2\pi[\sqrt{2}a_o/4)^2}{0.866a_o^2} = 0.907$$

The (111) is close packed.



3.49

Show that the theoretical density for ZnSe should be 5.2
when the lattice const. is 0.567 nm and the cryst
structure is that of zinc blende.

$a_0 = 0.567\ nm$

coordinate # of ZnSe = 4

$$\rho = \frac{(\#\ of\ Zn)(AW\ of\ Zn) + (\#\ of\ Se)(AW\ of\ Se)}{(Volume\ of\ unit\ cell)(N_A)}$$

$$\rho = \frac{(4)(6.38\ g/mol) + (4)(78.96\ g/mol)}{(0.567\ nm)^3(6.02 \times 10^{23}\ atoms/mol)}$$

$$\rho = 1.122 \times 10^{-20}\ g/nm^3 = 5.26\ g/cm^3$$

Q.E.D.

3.53 A sample of cubic SiC was analyzed using XRD. It was found that the (111) peak was located at 2θ of 16°. The wavelength (λ) of the X-ray radiation used in this experiment was 0.6975 Å. Show that the lattice const. a_0 of this form of SiC is 4.0867 Å.

Given. $\lambda = 0.6975$ Å

$(hkl) = (111)$

$2\theta = 16° \Rightarrow \theta = 8°$

$\sin\theta = \frac{\lambda}{2d}$ $\quad d_{hkl} = \frac{a_0}{\sqrt{h^2+k^2+l^2}}$

$d_{111} = \frac{\lambda}{\sin\theta} = \frac{0.6975 \text{ Å}}{\sin 8°} = 5.0117 \text{ Å}$

Also,

$d_{111} = \frac{a_0}{\sqrt{1^2+1^2+1^2}} = \frac{a_0}{\sqrt{3}}$

$\Rightarrow \frac{a_0}{\sqrt{3}} =$

$\Rightarrow a_0 = 4.$

4-14 What are the Miller indices of the slip directions

a. on the (111) plane in an FCC unit cell

b. on the (011) plane in a BCC unit cell?

Solution:

$[0\bar{1}1]$, $[01\bar{1}]$

$[\bar{1}10]$, $[1\bar{1}0]$

$[\bar{1}01]$, $[10\bar{1}]$

$[1\bar{1}1]$, $[\bar{1}1\bar{1}]$

$[\bar{1}\bar{1}1]$, $[11\bar{1}]$