



SNS COLLEGE OF TECHNOLOGY

(AN AUTONOMOUS INSTITUTION)
SNS Kalvi Nagar, Saravanampatti Post
Coimbatore - 641 035



Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai
Accredited by NBA & accredited by NAAC with 'A++' Grade, Recognized by UGC

Hexagonal closed packed Structure

The unit cell has one atom at each of the 12 corners
The unit cell has one atom at the center of the two faces
The unit cell has 3 atoms arranged in body.
It consists of 3 layers.
At bottom layer, the central atom has 6 nearest neighboring atoms in the plane.
The middle layer has 3 atoms and it is separated by the distance $c/2$ from bottom layer.
The top layer is similar to the bottom layer and at a distance c from the bottom layer.



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No. of atoms per unit cell

No. of atom in unit cell from the contribution of corner atoms (TOP) $\left. \vphantom{\begin{matrix} \text{No. of atom in unit cell from the contribution} \\ \text{of corner atoms (TOP)} \end{matrix}} \right\} = \frac{1}{8} \times 6 = 1$

No. of atom in unit cell from the contribution of corner atoms (bottom) $\left. \vphantom{\begin{matrix} \text{No. of atom in unit cell from the contribution} \\ \text{of corner atoms (bottom)} \end{matrix}} \right\} = \frac{1}{8} \times 6 = 1$

No. of central atoms in both upper & bottom planes $\left. \vphantom{\begin{matrix} \text{No. of central atoms in both upper \& bottom} \\ \text{planes} \end{matrix}} \right\} \frac{1}{2} \times 2 = 1$

No. of middle layered atom = 3

$$1 + 1 + 1 + 3 \Rightarrow 6$$

Co-ordination number

bottom

The atom 'x' is consist of

bottom layer atom = 6

above layer = 3

below layer = 3

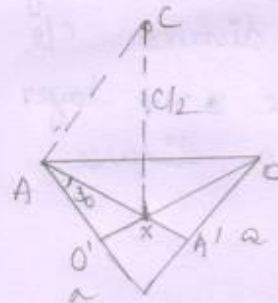
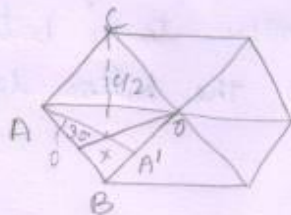
$$6 + 3 + 3 = 12$$

atomic radius

$$a = 2r$$

$$r = a/2$$

Calculation of c/a ratio





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height of the orbit cell = C

ΔABy

$$\cos 30^\circ = \frac{Ay}{AB}$$
$$Ay = AB \cos 30^\circ$$
$$Ay = \frac{a\sqrt{3}}{2}$$

x is center for ΔABO ,

$$Ax = \frac{2}{3} Ay$$
$$Ax = \frac{2}{3} \frac{a\sqrt{3}}{2} = \frac{a\sqrt{3}}{\sqrt{3}\sqrt{3}}$$
$$Ax = \frac{a}{\sqrt{3}}$$

ΔAxC

$$Ac^2 = Ax^2 + Cx^2$$

We know $Ac = a$, $Ax = \frac{a}{\sqrt{3}}$, $Cx = \frac{c}{2}$

$$a^2 = \left(\frac{a}{\sqrt{3}}\right)^2 + \left(\frac{c}{2}\right)^2$$
$$a^2 = \frac{a^2}{3} + \frac{c^2}{4}$$

rearrange the above term

$$a^2 - \frac{a^2}{3} = \frac{c^2}{4}$$
$$\frac{3a^2 - a^2}{3} = \frac{c^2}{4}$$
$$\frac{2a^2}{3} = \frac{c^2}{4}$$
$$\frac{2 \times 4}{3} = \frac{c^2}{a^2} \Rightarrow \frac{8}{3} = \frac{c^2}{a^2} \Rightarrow \frac{c}{a} = \sqrt{\frac{8}{3}}$$
$$= 1.633 //$$



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Packing factor
 $P.F = \frac{V'}{V}$

Volume of all the atoms per unit cell in HCP = $6 \times \frac{4}{3} \pi r^3$
 $= \frac{24}{3} \pi \left(\frac{a}{2}\right)^3$
 $= \frac{24}{3} \pi \frac{a^3}{8}$
 $= \pi a^3$

Area of base = $6 \times$ Area of triangle AOB
Area of triangle AOB = $\frac{1}{2} BO \cdot AY$
 $= \frac{1}{2} a \frac{a\sqrt{3}}{2} = \frac{a^2\sqrt{3}}{4}$
Area of base = $6 \times \frac{a^2\sqrt{3}}{4} = \frac{3\sqrt{3}a^2}{2}$
Volume of the unit cell = Base Area \times height 2
 $V = \frac{a^2\sqrt{3}}{2} \times c$
 $= \frac{3\sqrt{3}a^2c}{2}$

Packing factor = $\frac{V'}{V}$
 $= \frac{\pi a^3}{\frac{3\sqrt{3}a^2c}{2}}$
 $= \frac{2\pi a^3}{3\sqrt{3}a^2c} \Rightarrow \frac{2\pi \left(\frac{a}{c}\right)}{3\sqrt{3}}$
 $= \frac{2\pi}{3\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{2}\sqrt{2}} \Rightarrow \frac{\pi}{3\sqrt{2}}$
 $= 74\%$

74% of the unit cell is occupied by atoms.