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AN AUTONOMOUS INSTITUTION
Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai.

UNIT -IV CRYSTAL PHYSICS

1.10 EXPRESSION FOR DISTANCE BETWEEN SUCCESSIVE PLANES

Studying the distance between two successive crystals planes are very imported for the structure determination and to find certain crystal properties by x-ray diffraction methods.

Let us consider a rectangular Cartesian coordinate system and O is the origin. Let [h,k,l] are the Miller indices of plane ABC, which makes intercepts OA,OB and OC on x,y,z axes respectively as shown in the figure 1.11

Let ON is the normal to this plane such that ON= d1 the distance of the plane from the origin, makes angles α, β and γ with the three axes.

$OA = a/h$, $\cos\alpha = d_1/OA$, substitution the value of OA, $\cos\alpha = \frac{d_1}{a/h} = \frac{hd_1}{a}$

$OB = \frac{a}{k}$, $\cos\beta = \frac{d_1}{OB}$, on substituting the value of OB, $\cos\beta = \frac{d_1}{a/k} = \frac{kd_1}{a}$, $OC = \frac{a}{l}$,

$\cos\gamma = \frac{d_1}{OC}$, On substituting the value of OC

$$\cos\gamma = \frac{d_1}{a/l} = \frac{ld_1}{a}$$

As $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$ and substituting the values

$$\left(\frac{hd_1}{a}\right)^2 + \left(\frac{kd_1}{a}\right)^2 + \left(\frac{ld_1}{a}\right)^2 = 1$$

$\left(\frac{d_1}{a}\right)^2 (h^2 + k^2 + l^2) = 1$ Square rooting both the sides $\frac{d_1}{a}\sqrt{h^2 + k^2 + l^2} = 1$

Or $d_1 = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$ ... (4)

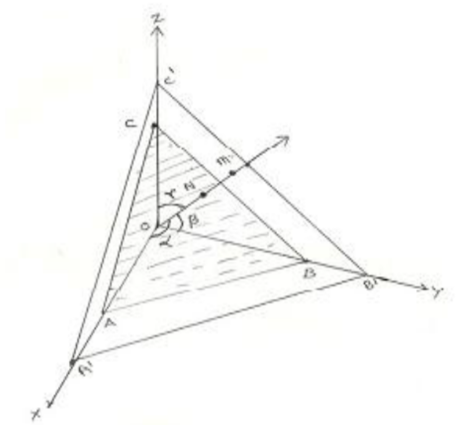

Fig1.11

Now let us consider another plane A' B' C' which is parallel to the plane ABC which is at a distance of d_2 from the origin O. Let the intercepts a OA'=OB'=OC'=2a and the normal to the plane passing through origin is OM such that d OM =2d.

$$OA^1 = \frac{2a}{h}, \cos\alpha = \frac{d_2}{OA^1}$$

Substituting the value of OA',

$$\cos\alpha = \frac{d_2}{2a/h} = \frac{d_2 h}{2a}$$

Similarly

$$\cos\beta = \frac{d_2 k}{2a} \text{ and } \cos\gamma = \frac{d_2 l}{2a}$$

As $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$, substituting the values in the equation and on simplification

$$\frac{d_2}{2a}\sqrt{h^2+k^2+l^2}=1 \quad \text{or}$$

$$d_2=\frac{2a}{\sqrt{h^2+k^2+l^2}} \qquad \ldots. \qquad (5)$$

The distance between two successive planes, $d = d_2 - d_1$

From equation (4) and (5)

$$d=\frac{2a}{\sqrt{h^2+k^2+l^2}}-\frac{a}{\sqrt{h^2+k^2+l^2}}$$

$$d=\frac{a}{\sqrt{h^2+k^2+l^2}} \qquad \ldots \qquad (6)$$