VIVEKANANDA COLLEGE

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KOLKATA-700063

NAAC ACCREDITED 'A' GRADE

Topic: MILLER INDICES -CRYSTAL STRUCTURE

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CRYSTAL STRUCTURE-2

MILLER INDICES

It is defined as the reciprocals of the intercepts made by the plane on the three crystallographic axes and they are used to designate plane in the crystal.

The three possible integers represented as (h k l) designates the plane in the crystal ,is the reciprocal of the intercept made by the planes on the crystallographic axes.

Procedure for finding Miller Indices

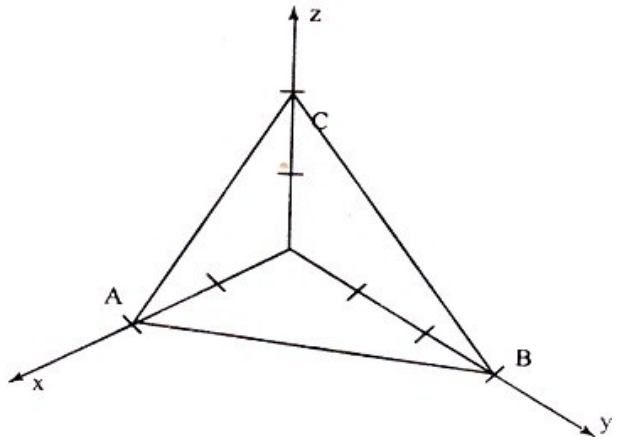
Step 1: The intercepts of the plane are determined along the axes X,Y and Z in terms of the lattice constants a,b and c.

Step 2: The reciprocals of these numbers are determined.

Step 3: The least common denominator (*lcd*) is obtained and multiplied with each by this *lcd*.

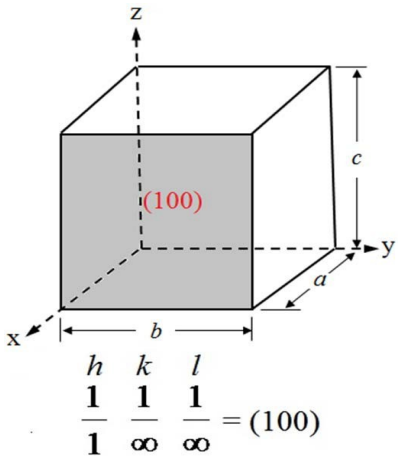
Step 4: The Miller indices are written within the parenthesis in the form of (h k l).

DETERMINATION OF ‘MILLER INDICES’FOR THEPLANE ABC HAVING INTERCEPTS OF 2 UNITS ALONG X-AXIS, 3 UNITS ALONG Y-AXIS AND 2 UNITS ALONG Z-AXIS.

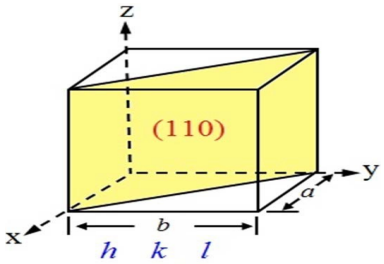


Step 1:2,3 and 2 are the intercepts on the three axes.
Step 2: The reciprocals are 1/2, 1/3 and 1/2.
Step 3: The least common denominator is ‘6’. Multiplying each reciprocal by lcd, we get, 3,2 and 3.
Step 4: Hence Miller indices for the plane ABC is (3 2 3)

MILLER INDICES OF FEW IMPORTANT PLANES



$$\frac{h}{1} \quad \frac{k}{\infty} \quad \frac{l}{\infty} = (100)$$



SDs

Consider a cubic crystal of side ‘a’, and a plane ABC.

This plane belongs to a family of planes whose Miller indices are (h k l) because Miller indices represent a set of planes.
Let ON =d, be the perpendicular distance of the plane A B C from the oirigin.

The relation between the interplanar distance and the interatomic distance is given by, for cubic crystal.
If (h k l) is the Miller indices of a crystal plane then the intercepts made by the plane with the crystallographic axes are given as where a, b and c are the primitives.

α', β' and γ' (different from the interfacial angles α, β and γ) be the angles between co-ordinate axes X,Y,Z and ON respectively.

The intercepts of the plane on the three axes are,

$$OA = \frac{a}{h}, \quad OB = \frac{a}{k} \quad \text{and} \quad OC = \frac{a}{l} \longrightarrow (1)$$

We have from the figure

$$\cos\ \alpha^1 = \frac{d_1}{OA}, \cos\beta^1 = \frac{d_1}{OB} \text{ and } \cos\gamma^1 = \frac{d_1}{OC} \longrightarrow (2)$$

From the direction of cosines

$$\cos^2\alpha^1 + \cos^2\beta^1 + \cos^2\gamma^1 = 1 \longrightarrow (3)$$

From equation 1 in 2, we get,

$$\cos\alpha^1 = \frac{d_1 h}{a}, \cos\beta^1 = \frac{d_1 k}{a}, \text{ and } \cos\gamma^1 = \frac{d_1 l}{a} \quad (4)$$

Substituting equation (4) in (3), we get,

$$\left(\frac{d_1 h}{a}\right)^2 + \left(\frac{d_1 k}{a}\right)^2 + \left(\frac{d_1 l}{a}\right)^2 = 1$$

$$\frac{d_1^2 h^2}{a^2} + \frac{d_1^2 k^2}{a^2} + \frac{d_1^2 l^2}{a^2} = 1$$

let us consider the next parallel plane.

Let OM=d_2 be the perpendicular distance of this plane from the origin.

The intercepts of this plane along the three axes are

$$OA^1 = \frac{2a}{h}, OB^1 = \frac{2a}{k}, OC^1 = \frac{2a}{l},$$

$$\therefore OM = d_2 = \frac{2a}{\sqrt{h^2 + k^2 + l^2}}$$

Therefore, the interplanar spacing between two adjacent parallel planes of Miller indices (h k l) is given by,

NM = OM - ON

Interplanar spacing are given by

$$d = (d_2 - d_1) = \frac{a}{\sqrt{h^2 + k^2 + l^2}} \qquad (6)$$