Crystal Physics

Miller Indices

Miller indices are a symbolic vector representation for the orientation of an atomic plane in a crystal lattice. It is defined as the reciprocal of the fractional intercepts which the plane makes with the crystallographic axes

Procedure for finding Miller indices

a) Find the intercepts of the plane along the co-ordinate axes X, Y and Z.
b) Take reciprocal of these intercepts.
c) Reduce the reciprocals into whole numbers using least common multipliers (LCM).
d) Write these integers within parentheses to get Miller indices.

For example, consider a crystal plane as shown in given figure

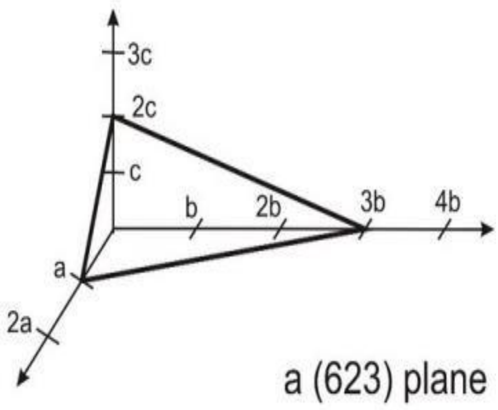

Figure: Plane ABC

1. Intercepts are 1, 3, 2.
2. Reciprocal of these intercepts are $\frac{1}{1}, \frac{1}{3}, \frac{1}{2}$
3. LCM of denominators 1, 3, and 2. Hence, multiplying by 6, we have $\frac{6}{1}, \frac{6}{3}, \frac{6}{2}$. The Miller indices of this plane is (6 2 3).

Features of Miller Indices

a) Plane passing through the origin has non zero intercepts.
b) All equally spaced parallel planes have same Miller indices.
c) Miller indices do not define a particular plane, but it defines a set of parallel planes.
d) If the plane is parallel to any one of the coordinate axes, then its intercepts will be at infinity.Therefore, the miller index of that particular axis is zero.
e) If a plane cuts the axis on the negative side, then the corresponding Miller indices will benegative.

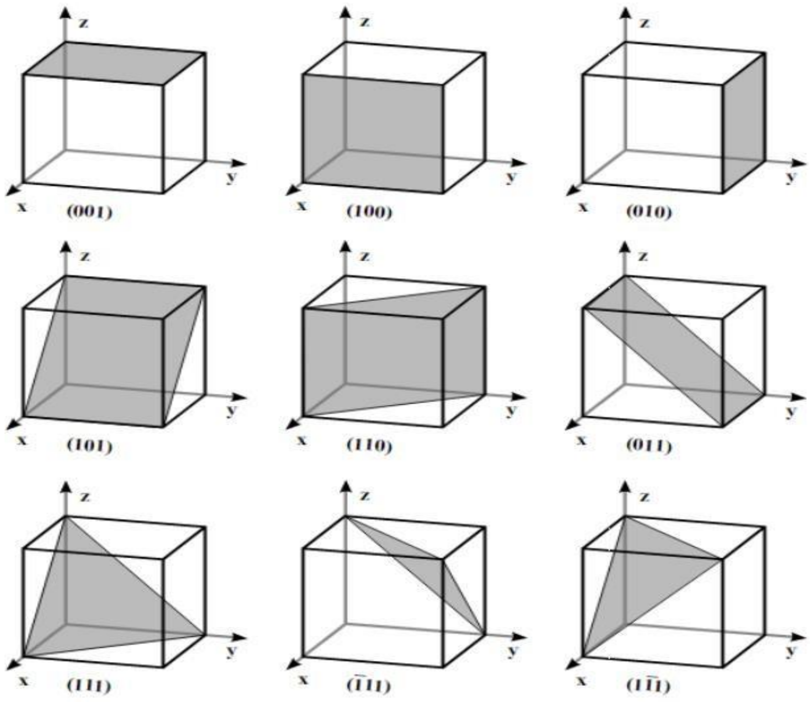

Figure: Different planes of a crystal

Interplanar distance (or) 'd' spacing in cubic lattice

Definition: The distance between any two successive planes is called d spacing or interplanar distance. Let us consider a cubic lattice of length „a" with two planes ABC and A′ B′ C′. Let d1 and d2 be the distance between the origin and the first (ABC) and second plane (A′ B′ C′). Let d be the distance between the two planes ABC and A′ B′ C′

Let us assume that the second plane lies in the origin. So we can find the distance between the origin and first plane instead of finding the distance between the two planes.

The plane AB makes the intercepts OA,OB and OC on X,Y and Z axis respectively.

OA:OB:OC = 1/h:1/k:1/ l

Multiply by lattice constant "a"

OA=$\frac{a}{h}$ OB=$\frac{a}{k}$ OC=$\frac{a}{l}$

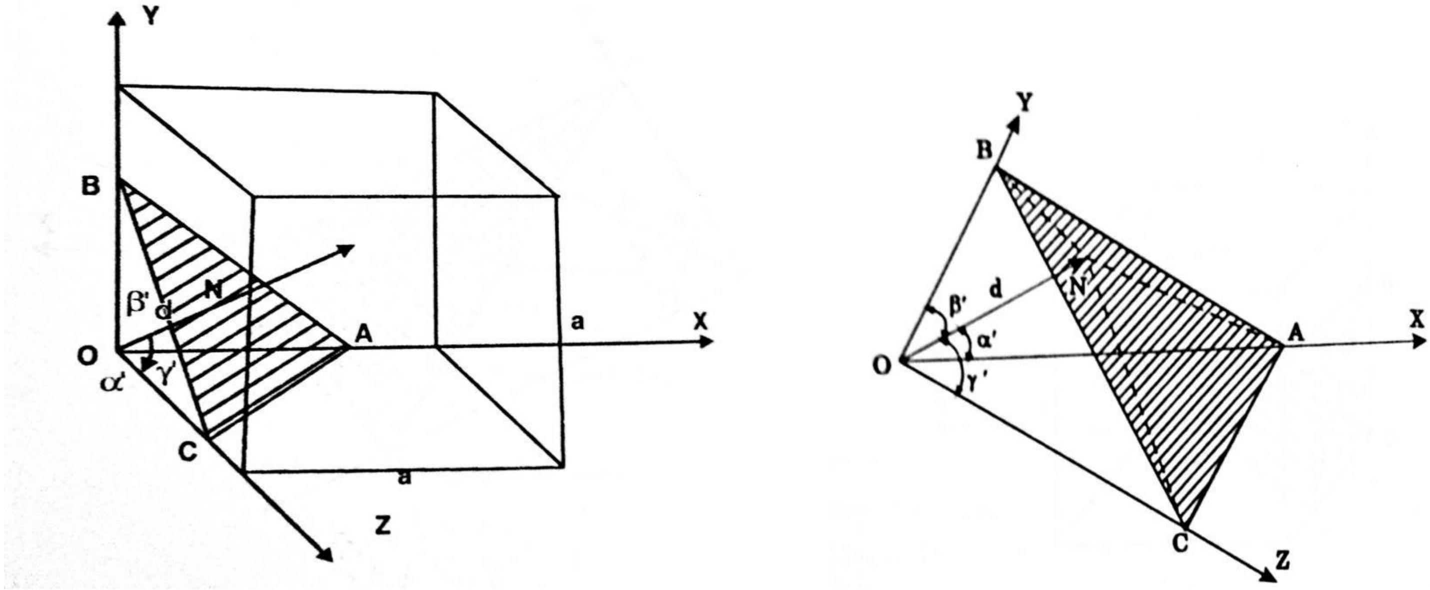

Figure: Inter planar spacing

According to the law of conservation of energy

$$\cos^2 a' + \cos^2 Q' + \cos^2 \gamma' = 1$$

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

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

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

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