THE SOLID STATE

CLOSE PACKED STRUCTURES

CLOSE PACKING OF IDENTICAL SOLID SPHERES

The solids which have non-directional bonding, their structures are determined on the basis of geometrical consideration. For such solids, it is found that the lowest energy structure is that in which each particle is surrounded by the greatest possible number of neighbours. In order to understand the structure of such solids, let us consider the particles as hard sphere of equal size in three directions. Although there are many ways to arrange the hard spheres but the one in which maximum available space is occupied will be economical which is known as closed packing.

Now we describe the different arrangements of spherical particles of equal size.

PACKING IN SOLID - ONE DIMENSIONAL

In one-dimension close packing, spheres are arranged in a row such that adjacent atoms are in contact with each other. The coordination number is defined as the no. of the nearest neighbour particles. In the case of one-dimensional close packing, the coordination number is equal to two.



When the spheres are packed in a plane i.e. There are two types of close packing.

TWO DIMENSIONALLY CLOSE PACKING:

(i) The centres of the spheres lie one below another. This type of arrangement is called square close packing. In such packing one sphere touches four other spheres. In this case 52.4% of the volume is occupied. The remaining 47.6% of the volume is empty and is called void volume. In square close packing co-ordination number is 4



Square close packing

(ii) Another type of arrangement of atoms is shown below. This type of packing is called hexagonal close packing. In such packing one sphere touches six other spheres. In this case 60.4% of the volume is occupied. The remaining 39.6% of the volume is empty and is called void volume. Therefore, this type of packing is more stable than the square close packing.



Hexagonal close packing

THREE DIMENSIONALLY CLOSE PACKING:

In hexagonal close packing, there are two types of the voids (open space or space left) which are divided into two sets 'b' and 'c' for convenience. The spaces marked 'c' are curved triangular spaces with tips pointing upwards whereas spaces marked 'b' are curved triangular spaces with tips pointing downwards.



Now we extend the arrangement of spheres in three dimensions by placing second close packed layer (hexagonal close packing) (B) on the first layer (A). The spheres of second layer may place either on space denoted by 'b' or 'c'. It may be noted that it is not possible to place spheres on both types of voids (i.e., b and c). Thus, half of the voids remain unoccupied by the second layer. The second layer also have voids of the types 'b' and in order to build up the third layer