

Fig. Tetrahedral  $sp^3$  bonding (very hard!)

The diamond structure has an FCC space lattice and a basis comprising two identical atoms. Alternatively, the structure may be viewed as two interpenetrating FCC lattices, one displaced relative to the other along a body diagonal by a quarter of its length.

The atoms on four atoms shown inside the main FCC sub lattice are from other interpenetrated FCC sub lattices.

Relatively few elements exist in the diamond structure. Carbon is the most obvious example, but the importance of this structure in solid state physics is mainly due to the fact that this is the natural state of the semiconductors silicon and germanium.

Many two-element compounds form in a diamond-like structure in which the first element occupies one FCC sublattice and the second element the other. This structure is named after its prime example, ZnS.

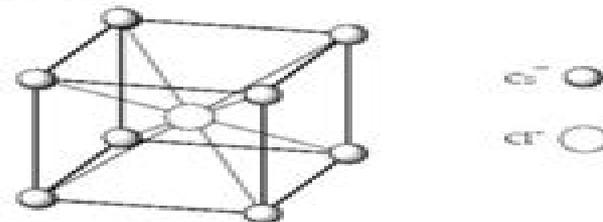
**Position of Carbon atoms are at**

First kind: (000), (100), (010), (001), (101), (110), (011), (111),  $(\frac{1}{2}, 0, \frac{1}{2})$ ,  $(\frac{1}{2}, \frac{1}{2}, 0)$ , (1,  $\frac{1}{2}, \frac{1}{2}$ ),  $(\frac{1}{2}, \frac{1}{2}, 1)$

Second kind:  $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$ ,  $(\frac{1}{2}, \frac{1}{2}, \frac{3}{2})$ ,  $(\frac{3}{2}, \frac{1}{2}, \frac{1}{2})$ ,  $(\frac{3}{2}, \frac{1}{2}, \frac{3}{2})$

**CsCl**

It contains atoms at the corners of a cube and at the body centre of the cube. Note that it is NOT a body centered cubic structure (as the atom at the centre is different to the atom at the corners of the cube).



In the cesium chloride (CsCl) structure, the space lattice is simple cubic. There are two such simple cubic lattices which are separated by one half of the body diagonal of the unit cube. One lattice is occupied by Cs atoms, the other by Cl atoms.

Each atom has 8 nearest neighbors of the opposite kind and is bound to these 8 atoms which are arranged at the corners of the surrounding hexahedron (cube). The bonding is typically ionic. The dimensions of the CsCl unit cell are  $a = b = c = 4.123 \text{ \AA}$

**Problems:**

Obtain the miller indices of a plane which intercepts at a, b/2, 3c in a simple cubic unit cell.

Solution  $x = a, y = b/2$  and  $z = 3c$

# Engineering Physics 1 Year Notes Crystal Structures

**R Barnett**



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