

## Structure of the Elements P, S and C

### **Carbon**

Elemental carbon occurs in several different forms, it displays a complex allotropy, and the main forms are:

#### **DIAMOND STRUCTURE**

It crystallizes in the cubic crystal system with a ccp arrangement of C and additional C-atoms in half of the tetrahedral holes. Each carbon atom forms a single bond with four adjacent C atoms at the corners of regular tetrahedron. The result is rigid, covalent, strongly bonded 3 dimensional structure. Diamond is good electrical insulator and good conductor of heat because of strong bonding in the molecule. Pure diamonds are always transparent and colourless. Diamond is the hardest known naturally occurring material.

#### **GRAPHITE STRUCTURE**

Graphite crystallizes in a layer structure. The layers consist of 6-rings. Each C atom forms three covalent  $\sigma$  bonds to further carbon atoms. These bonds made up of  $sp^2$  hybrid orbitals. The remaining p orbitals, which are perpendicular to plane of  $\sigma$  bonds, overlap to form a delocalized  $\pi$  system. The layers are widely separated, they are held together only by weak van der Waals forces.

Graphite is an electrical conductor.

**FULLERENE STRUCTURE:** if sheets of graphite were bent which in practise achieved by replacing some of the six membered rings by five membered rings, then fullerene may be formed. The most important one;  $C_{60}$ . It has the shape of soccer ball and icosahedra symmetry. If  $C_{60}$  molecule is splitted in half, two hemispheres can be placed on the ends of a rolled up sheets of graphite; what is known as a nonotubes.

### **SULFUR**

Common yellow sulphur contains  $S_8$  molecules where eight atoms are connected in a crown-shaped ring. Additionally sulphur occurs in other ring sizes e.g.  $S_6$ ,  $S_7$ ,  $S_8$ ,  $S_{10}$ ,  $S_{11}$ ,  $S_{12}$ ...In molten Sulphur chains of different length are formed.

### **PHOSPHOR**

P has three main allotropes:

**White phosphorus** contains only four atoms in tetrahedral arrangement resulting in very high ring strain and instability. It is waxy transparent solid, which glows greenishly in dark. It is highly flammable and self-igniting upon contact with air and toxic.

**Red phosphorus** can be obtained by heating white P, at 300C in an inert atmosphere for several days. Amorphous solid have very complex 3D network structures

When phosphorus is heated under high pressure a series of phases of **Black phosphorus** are formed. One of these phases consists of pucked layers composed of pyramidal 3 coordinate phosphorus atoms.