The Chemistry of Boron (a non-metal element)

Main ore: Borax ($Na_2B_4O_7 .10H_2O$) found in Mojave Desert California

The element B has several different forms depending on its purity.

e.g. 95% pure B, amorphous ("without form ") brown powder .

99% pure B, grey /black solid (Mp 2250°C)

There are several **allotropes** of 99% pure Boron. They differ in structure. They consist of B_{12} icosahedra packed in different ways. (An icosahedron is a twenty sided figure)

Boron compounds containing hydrogen :

Boron forms an extensive range of molecular hydrides called **boranes**

e.g. B_2H_6 (diborane - a colourless gas)

$B_{10}H_{14}$ (decaborane –a white solid Mp. 98°C)

The boranes are electron deficient compounds.

(There are other electron deficient compounds e.g. "BeH_2")

Heavy boranes are stable to moist air but are made from the lighter boranes which spontaneously react with water $\rightarrow B(OH)_3$ (boric acid) (see later)

Diborane is prepared from the simplest borane anion (**boride**) called Sodium Borohydride $NaBH_4$. Both diborane and sodium borohydride are important reagents in organic chemistry,

$NaBH_4$: good reducing agent (source of H^-)

B_2H_6 : adds to alkene bonds in a reaction called **hydroboration** in which it converts alkenes into alkanes via an anti –markownikoff addition .

Lewis structures (see your Lecture Notes)

BF_3 and BCl_3 are widely used to promote organic reactions because of their **Lewis acidity**. They react to form **adducts** with many organic molecules e.g. $(CH_3CH_2)_2O.BF_3$.

All the Boron trihalides (except BF_3 see below) are **hydrolysed** in a violent reaction –

e.g $BCl_{3(g)} + 3H_2O_{(l)} \rightarrow B(OH)_3 + HCl$

BF_3 is unusual because it is only partially hydrolysed (some B-F bonds remain in the product)

$4BF_3 + 6H_2O \rightarrow 3H_3O^+ + 3BF_4^- + B(OH)_3)$

$BF_4^- + H_2O \rightarrow [BF_3OH]^- + HF.$

Why is $B(OH)_3$ called boric acid ? $B(OH)_3 + H_2O \rightarrow H^+ [B(OH)_4]^-$

Boric acid accepts electrons. It is **LEWIS ACID**.

B has a diagonal relationship with Si

Similarities

1. Semi-conducting non-metals .

2. Form oxygen – bridged structures .

3. Form halides that are hydrolysed in water (exception BF_3).

4. B_2O_3 and SiO_4 have acidic character.

5. Borates- contain planar BO_3 units (or less commonly tetrahedral BO_4 units) which share oxygen atoms to make chains or rings. Sometimes boron oxides are added to silica because their structures are similar.

   (When silicates are heated the compound melts. The structure alters and on cooling an amorphous glassy material called 'fused silica' is formed. If 16% B_2O_3 is added this gives rise to borosilicates (“pyrex”) .)

6. BH_3, SiH_4 are volatile and flammable.

Differences:

1. Boron hydrides –structurally unique.
   silicon hydrides – Silanes are chain-like e.g. Si_nH_{2n+2}.

2. Oxidation states are different