NOTES ON P-BLOCK ELEMENTS

- P block is present at extreme right of periodic table.
- It has general electronic configuration **ns^2np^{1-6}**.
- It includes solids, liquids and gases.
- The elements of this group are metal, non- metal and metalloids.
- If we move along period in periodic table, non-metallic character increases and if we move down the group, the non-metallic character decreases.
- In this group: As we move down, the lower oxidation state becomes more stable due to" **Inert pair effect."**

Inert pair effect: It is "reluctance in the participation of s electrons in bond formation due to poor shielding effect by d and f orbital. As a result, s electrons are tightly bounded.

1^{st} member is different from its congeners due to:

- Small size
- Highest ionization energy.
- High electro-negativity.
- No vacant d orbital.
- They show maximum co-valence of 4 because of no vacant d orbital.
- First member also has tendency to form multiple bonds because in them p can takes place (because of its small size).

Group -13

This group includes following elements:

- Boron (B)
- Aluminium (Al)
- Gallium (Ga)
- Indium(In)
- Thallium (Tl)

Boron occurs as Borax, kernite, orthoboric acid etc. Aluminum occurs as bauxite, Cryolite, Corundum etc.

General electronic configuration of this group: ns^2np^1

Boron (B) $[He]2s^2 2p^1$
Aluminum (Al) $[Ne]\ 3s^2 3p^1$
Gallium(Ga) $[Ar]3d^{10}\ 4s^2 4p^1$
Indium(In) $[Kr]4d^{10}\ 5s^2 5p^1$
Thallium (Tl) $[Xe]4f^{14} 5d^{10} 6s^2 6p^1$

Physical properties of group 13:

1. **Atomic size and Ionic radii**:

- If we compare group 11 with group 13, then group 13 is smaller due to increased nuclear charge. e.g. Out of Be and B ,Boron is smaller .
- Down the group, size increases because nuclear charge decreases (due to addition of new shell).
- Expected order : B <Al<Ga<In<Tl
- But actual the order is :B < Ga<In<Tl
- The reason behind it: Due to filling of d-orbital in Gallium, the effective nuclear charge on valence electron increases (because of poor shielding effect by d and f orbital). Therefore, nucleus pull electron more effectively and size decreases.

- That is the reason, Gallium is smaller than Aluminium (because Gallium has d-electrons and Aluminium doesn't have) .

2. **Ionization energies**

- If we compare ionization energy of group 13 and group 2, we can say that the ionization of group 13 is more, because of their small size and increased nuclear charge. But actually group 2 has high ionization energy, than group 13 due to completely filled s orbital in group 2 elements.
- In case of Be and B, the electronic configuration of Be is $1s^2 2s^2$ and in boron it is $1s^2 2s^2 2p^1$. So, due to this reason the ionization energy of Boron is less than Beryllium.
- Down the group ionization energy decreases, as the size increase and nuclear charge decrease. So , the expected order is : B>Al>Ga>In>Tl. But actually it is : B>Al> In>Tl due to poor shielding effect by d electrons in gallium.

3. **Electronegativity:** If we compare with group 2, they are more electronegative due to increased nuclear charge. Along group: It decreases, but the expected order is this B>Al> In>Tl. This is again due to poor shielding effect.

4. **Electropositive character**: As compared to group 2, they are less electropositive due to increased nuclear charge. Down the group: The size increases. Therefore, metallic character increases.

B	Al	Ga	In	Tl
Non metal	amphoteric	less metallic	metallic	metallic

5. **Oxidation state**: It depends on electronic configuration .As their electronic configuration is ns^2 np. So, oxidation states shown by them are +3,+1.
Boron: Shows exceptional behaviour because of its small size and high ionization energy. It actually faces difficulty in loosing electrons .Therefore, it forms covalent bond.

B	Al	Ga	In	Tl
(+3)	(+3)	(+3,+1)	(+3,+1)	(+1)

This is basically due to inert pair effect.

Chemical properties of group 13

- Out of all elements of this group, Boron is non-reactive. This is because of its small size as it has high ionization energy .So, reactivity increases down the group.
  B < Al < Ga < In < Tl
- In this Boron is least reactive because of its small size and high ionization energy and Thallium is most reactive because of its low ionization energy.
- **Aluminium**: When react initially, it keeps reacting .But after some time, a layer of its oxide is formed over its surface. This layer prevent it from further reacting .So, it becomes passive after some time.
- Most of the compounds of this group are electron deficient that is their octet is not complete. So, they behave as Lewis acids.
  Example: BX_3 (only 6 electrons in valence shell of Boron).
  Therefore, it forms coordinate bond.
  $BX_3 + NH_3 \rightarrow [NH_3 \rightarrow BF_3]$coordinate bond

That means, they have tendency to take electrons. Or, we can say they are Lewis acids. But down the group, acidic character decreases (that is tendency to attract incoming electron decreases). BX_3> AlX_3 > GaX_3 >InX_3 >TlX_3

- Lewis acid strength decreases because size increases .As a result, attraction towards incoming electron decreases.

1. **Reactivity towards oxygen : Forms oxides**

- Boron does not react with oxygen at ordinary temperature due to small size and high ionization energy.
- If we react Al with oxygen, it reacts at normal temperature. With time it forms a protective layer of oxide on its surface. This layer makes it non-reactive.
  $Al + 3O_2 \rightarrow 2Al_2O_3$
- They react with nitrogen gas also, to form compound with formula EN.
  Example: $6Al + 3N_2 \rightarrow 6AlN$
- If we see acidic strength of oxides, then it decreases down the group.

BeO	Al_2O_3	GaO	InO	TlO
beryllium oxide	aluminum oxide	gallium oxide	indium oxide	thallium oxide
(acidic)		(amphoteric)	(all are basic)	

2. **Reaction with water: Hydroxides are formed of type E(OH)**

- Boron does not react with water.
- Aluminium reacts with cold water that is :
  $Al + H_2O \rightarrow Al(OH)_3 + H_2$
- Gallium and indium neither react with cold water nor with hot water.
- Thallium reacts with water but form protective layer which make it passive.

3. **Reactivity towards acids and bases**:

- Boron doesn't react with acids and bases at normal temperature, but reacts with strong acids.
- Aluminium reacts with acid and base because it is amphoteric in nature.

$Al + HCl \rightarrow AlCl_3 + H_2$

$Al + NaOH \rightarrow [NaAl(OH)_4]$

Aluminium sodium hydroxide sodium tetrahydroxoaluminate

3. Al when react with nitric acid, initially it reacts but after same time it became passive.

4. **Reaction with Halogens: Form halides of type EX_3**

$2B + 3X_{2-} \rightarrow 2BX_3$

$B + F_2 \rightarrow BF_3$

$Al + Cl_2 \rightarrow AlCl_3$

All halides are Lewis bases.

Important trends

Formation of Hydrides : EH_3

- Thermal stability of hydrides decrease down the group .Out of all, only BH_3 is stable.

B_nH_{n+4} , B_nH_{n+6}= Boranes

Simplest Borane :B_2H_6(diborane)

This diborane **has banana** odour and it is weak Lewis acid.

Formation of Halides: They form their respective halides. Out of all halides aluminium chloride $AlCl_3$exist as dimer that is Al_2Cl_6 (all halides behave as Lewis acids)

- They will behave as Lewis acids only, if they attract incoming electrons.
- Trends of strength of Lewis acids :
- $BF_3>AlCl_3>BBr_3>BI_3$(expected order)
- $BF_3<AlCl_3>BBr_3>BI_3$(actual)

Explained on the basis of back bonding:

- In case of BF_3, in Boron there is one vacant 2p orbital (i.e. $2s^2$, $2p^1$)in ground state.
- In excited state, it will be $2s^1$, $2p^2$ and energy of 2p orbital of B and F are almost similar.
- As a result, one of the 2p filled orbital overlaps sidewise with the vacant 2p orbital of boron atom resulting in transfer of electrons from Fluorine to vacant 2p orbital.
- This is called back bonding.
- Now it doesn't have fewer electrons therefore, Boron no longer act as a Lewis acid.
- As size increases, the tendency of back bonding decrease and acidic strength increase.

Uses of Boron

- Boron is used as semi-conductor for making electrical appliances.
- It is used in steel industry for hardening.
- Its compounds like borax and boric acid are used in glass industry.
- Borax is used for soldering metals.
- Borax fibers are used in making bullets.

Uses of Aluminum

- It is soft and light metal, non toxic and is used for wrapping food items.
- It I used in making electric power cables.
- It is used as packaging of food items.
- It is used I making cans for cold drink etc.

Alloys of Aluminum

- Bronze : Aluminium and Copper are its constituents .It is used for making coins ,jewellery etc
- Magnalium: its constituents are Al and Mg.
  It is used for making pressure cookers, balance beams etc.
- Duralumin: its constituents are: Al, Cu, Mg and Mn.

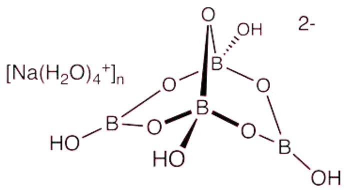
It is used for making bodies of air craft's, helicopters, ships etc.

- ALNICO: Its constituents are AL, Ni and Cobalt.

It is used in making powerful magnets.

→Borax

1. **Borax: $Na_2B_4O_7.10H_2O$**



Borax

Preparation

- **From Colemanite ore**: It is prepared from Colemanite ore (calcium ore).
- In this ore is made to react with sodium carbonate.
- Then it is heated as shown in reaction :

$Ca_2B_6O_{11}$ + Na_2CO_3 -→ $CaCO_3$ + $Na_2B_4O_7$ + $NaBO_2$

Colemanite ore sodium carbonate calcium carbonate Borax sodium metaborate

- The solution has White precipitate.
- When these precipitates are filtered, the solution becomes concentrated.
- Finally, we get crystals of borax on cooling.
- **From Boric acid** : In this also boric acid is made to react with Sodium carbonate to form Borax ,carbon dioxide and water as shown below:

H_3BO_3 + Na_2CO_3 -→ $Na_2B_4O_7$ + CO_2 + H_2O

Boric acid sodium carbonate borax carbon dioxide water

Properties of Borax

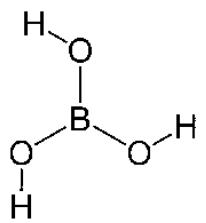
- It is white crystalline solid.
- On heating, it loses water of crystallization and form Na_2B_4O
- On further heating, it gives white transparent liquid which further on cooling gives white transparent bead.
- This bead is made to react with different types of salts.
- When reacted ,it gives different colour with different metal ions like :
  With Ni^{2+} → brown
  With Co^{2+} → blue
  With Cr^{3+} → green
  With Mn^{2+}→pink
  With Cu^{2+}→ blue

Uses of Borax

- It is used in laboratory as Borax bead test.
- It is used in making enamels for pottery.
- It is used in candle making.
- It is added in soaps due to its antiseptic properties.
- It is used in optical glass.

1. **Ortho boric acid**

Chemical Formula :- H_3BO_3 or $B(OH)_3$



Orthoboric acid

Preparation: It is prepared from Borax.

$Na_2B_4O_7.10H_2O$ + HCl + H_2O → H_3BO_3 + NaCl

Borax hydrochloric acid boric acid sodium chloride

Properties

- It is white crystalline solid with soapy touch.
- It is sparingly soluble in cold water but soluble in hot water.
- At 373k, it forms metaboric acid.

$H_3BO_3 \xrightarrow{\text{at 373K}} HBO_2 \xrightarrow{\text{at 433K}} H_2B_4O_7 \xrightarrow{\text{further heating}} B_2O_3$

(boric acid) (metaboric) (tetraboric acid) (boric oxide)

- It behave as Lewis acid because of its formula $B(OH)_3$

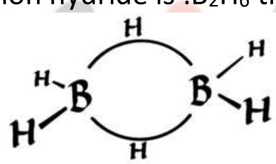
Uses

- It is used in manufacturing of enamels.
- It is used as food preservative.
- It is used in medicines for eye wash.

Boron hydrides

The molecular formula is B_nH_{2n+4}

The common hydride is :B_2H_6 that is diborane.



Diborane

Preparation: It is prepared by reacting Sodium boron hydride with Iodine:

$NaBH_4$ + I_2 → B_2H_6 + NaI + H_2

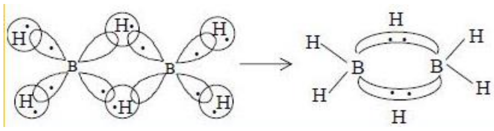
Sodium borohydride iodine diborane sodium iodide

Properties

- It is colourless and toxic gas.
- It catches fire spontaneously.
- It is only stable at low temperature.
- It is easily hydrolyzed.

Structure of diborane:

- In this structure, there are 2 types of Hydrogen atoms.
- The types: 4 terminal Hydrogen and 2 Hydrogen atoms are called bridged atoms.
- The 4 terminal Hydrogen are bonded by normal covalent bond and 2 bridged Hydrogen atoms by are bonded by 3 centre electron pair bonds as shown :



Both the Boron will have in total 2 empty d orbital.

- Each 2p orbital overlaps with 1s orbital of H atoms.
- The 2 hybrid orbital left on each Boron atom contain an unpaired electron and other is empty.
- The orbital containing one electron of one boron atom and the other empty orbital of second boron atom form a bond with hydrogen atom simultaneously to give B-H-B bond.
- Each Boron form 2 covalent bond.
- Out of 3 unpaired electrons, the left electron of both the boron is 2 and of 2 Hydrogen atom is also 2.
- Therefore, it forms 3 bonds instead of 2 bonds.

Introduction to Group -14

This group includes the following elements:

Carbon (C)

Silicon (Si)

Germanium (Ge)

Tin (Sn)

Lead (Sb)

Electronic configuration

- Carbon (C) : [He]$2s^2 2p^2$
- Silicon(Si):[Ne]$3s^2 3p^2$
- Germanium (Ge):[Ar]$3d^{10} 4s^2 4p^2$
- Tin (Sn):[Kr]$4d^{10} 5s^2 5p^2$
- Lead(Pb):[Xe]$4f^{14} 5d^{10} 6s$

Chemical properties of group 14

They are non reactive but reactivity goes on increasing down the group due to decrease in ionization energy.

1. **Reactivity towards oxygen** : They form two types of oxides

- Monoxides (MO)
- Dioxides (MO_2)

That is :

- Monoxides : CO, SiO, GeO, SnO, PbO
- Dioxides: CO_2, SiO_2, GeO_2, SnO_2, PbO

Out of them:

- Co: Neutral
- SiO: is not so stable
- GeO: Weakly acidic
- SnO and PbO : Amphoteric
- CO_2, SiO_2 : Acidic
- GeO_2: Amphoteric
- SnO_2 and PbO_2: weakly basic

Out of them, CO Is strongest reducing agent because it has ability to accept oxygen and form stable oxide that is carbon dioxide .The solid form of carbon dioxide is called **dry ice** and the commercial name of dry ice is **drikold**. Out of them PbO_2 is strongest oxidizing agent .

1. **Reaction with water**: They form hydroxides.
- In this group, Carbon does not react with water.
- Tin reacts with steam forming SnO_2+H
- Ge,Sn Pb –do not react with water due to formation of protective layer of oxide on it .

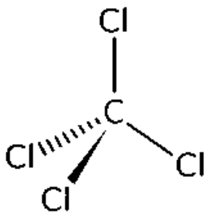
2. **Reaction with halogens**: Halides are formed (EX_4).

The halides formed are :

CCl_4	$SiCl_4$	$GeCl_4$	$SnCl_4$	$PbCl_4$
			$SnCl_2$	$PbCl_2$

All are tetrahedral in nature.

Structure of CCl_4:



Structure of carbon tetrachloride

- Stability of halides of formula EX_2 , increases down the group due to inert pair effect .
- Out of all, $SnCl_2$ and $PbCl_2$ both are stable.
- CCl_4 can't be hydrolyzed easily whereas $SiCl_4$ can be easily hydrolyzed:

The reason being, that carbon has no d orbital.

As a result carbon cant increase its oxidation number beyond 4 .On the other hand Si has d orbital therefore, it can easily form bond with water by extending its octet. That is the reason it can be hydrolyzed.

3. **Reaction with hydrogen** : hydrides are formed (EH_4)

They form respective hydrides:
- CH_4 SiH_4 GeH_4 Sn and Pb do not form as they are less reactive towards hydrogen.
- Carbon has maximum tendency to form hydrides in its own family .these hydrides have covalent bonding in them and a tetrahedral geometry.

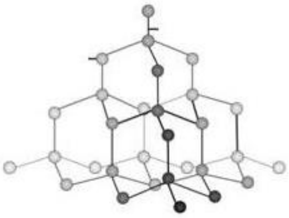
Allotropes of carbon

Allotropes: Are the different forms of elements having same physical properties but different chemical properties.

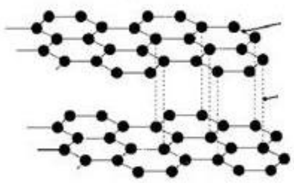
Allotropes of carbon
- Crystalline form :Diamond ,Graphite and Fullerene
- Amorphous forms of carbon : Coke ,Charcoal ,lamp black

Diamond

In this carbon is sp^3 hybridized .Each carbon attached to four carbon atom giving rise to compact three dimensional structures given below:


diamond

- Graphite: in this carbon is sp^2 hybridized and each carbon is covalently attached to two other carbon ,such that it gives hexagonal rings (sheet like structure).


graphite

- The layers are held by weak Vander wall forces, such that they can slide over one another.

Properties and Uses of diamond and graphite

Diamond

- It is hardest substance. Therefore, used as cutting tool.
- It is bad conductor of electricity because it has no free electrons.

Graphite:

- It has soft structure because of Vander wall forces in it.
- Therefore, used as Lubricant.
- It is used to make pencil leads, as it marks the paper black.
- Moreover, it is good conductor of electricity as it has free electrons.

Uses of Diamond

- It is used as cutting tool.
- It is used in making jewellery.
- It is used in manufacturing of tungsten filament.

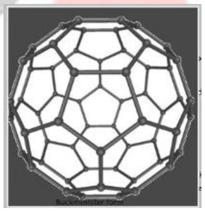
Uses of Graphite

- It is making electrodes.
- It is used as lubricant
- It is mixed with clay or wax to make lead pencils
- It is used to making moderator of nuclear reactor.

Both Diamond and Graphite are crystalline forms of Carbon.

- **Fullerenes**: It is having many Carbon atoms ranging from C_{32} to CIt was studied in 1985 and after 10 years it came in notice or structure. The carbon atoms are in a shape of football .

Buckminster form :



Amorphous forms of Carbon : In this the molecules are arranged in haphazard manner .

- Coke: Used as fuel.
- Charcoal : Is porous

Types of Charcoal:

- Wood charcoal
- Animal charcoal

- Sugar charcoal

(They are obtained by destructive distillation of wood, sugar etc).

- Charcoal is good absorbent, if dipped in coloured solution it will adsorb all colours, leaving behind colourless solution.

Uses of Carbon

1. It is used in the form of fuel.
2. It is used in manufacturing of coal gas, water gas etc.
3. It is also used as a good reducing agent in metallurgy.
4. It is activated charcoal and is used as catalyst.

Uses of Silicon

1. It is used to form n-type or p-type semiconductor.
2. It is important component of glass and cement.
3. Pure Si is used to make computer chips.

Uses of germanium

1. It is used in transistors.
2. It is making for lenses and prism.
3. It is used as scientific apparatus.

Uses of lead

1. It is used for making lead sheets and pipes.
2. It is used for telephone wires.
3. It is used in storage batteries and bullets.

Uses of Tin

1. It is used for electroplating.
2. It is used in making alloys: Pb, Cu and Sn.
3. It is a type metal: Pb ,Sn ,Sb.

Carbon monoxide (CO)
Preparation

- It is prepared from incomplete combustion of carbon as given in reaction below :

$C + \frac{1}{2} O_2 \rightarrow CO$

Carbon oxygen carbon monoxide

- Heating Methanoic acid in presence of sulphuric acid at temperature 473-1273 k.

$HCOOH + H_2SO_4 \text{-- >} CO + H_2O$

Methanoic acid sulphuric acid carbon monoxide and water

- Commercial preparation: Heating Coke with water at high temperature.

$C + H_2O \rightarrow CO + H_2$

Carbon water syn gas

If we mix carbon in air :

$C + O_2 + 4N_2 \rightarrow CO + N_2$

carbon oxygen nitrogen carbon monoxide and nitrogen gas

Properties

- It is colourless and odourless.
- It is insoluble in water.
- It is highly toxic in nature as it combines with Haemoglobin,to form defective complex .As a result, the oxygen carrying capacity of RBC gets reduced.
- It burns in air to form carbon dioxide.

Uses

- It acts as reducing agent in extraction of metals.
- It reacts with certain metals to form Metal carbonyls.
- It forms synthesis gas that has industrial advantage.
- It forms producer gas that has industrial advantage.

Carbon dioxide (CO_2)

Preparation

- From complete combustion of Carbon and Carbon containing fuels in excess of air:

  $C + O_2$ -- >CO_2

  carbon oxygen carbondioxide

  CH_4+ O_2 --.>CO_2 + H_2O

  Methane carbon dioxide and water

Properties

- It is colourless and odourless.
- It is soluble in water.
- It is non supporter of combustion.
- It combines with water to for Carbonic acid (weak dibasic acid).

Uses

- It forms carbonic acid which undergo dissociation as :

$$H_2CO_3 + H_2O \rightarrow HCO_3^- + H_3O^+$$

Carbonic acid water bicarbonate ion hydronium ion

$$HCO_3^- + H_2O \rightarrow CO_3^{2-} + H_3O^+$$

Bicarbonate ion water carbonate ion hydonium ion

This H_2CO_3 and HCO_3^- helps in maintaining pH of blood between 7.26 to 7.42.

- Carbon dioxide is used by plants for photosynthesis: If the percentage of this gas increases in atmosphere, it has adverse affect like green house effect, which further results in ecological imbalance .
- Dry ice (solid form of carbon dioxide) is used as refrigerant for ice creams and frozen food.
- Gaseous carbon dioxide is used in carbonated soft drinks.
- Carbon dioxide is used in fire extinguisher as it is non supporter of combustion.

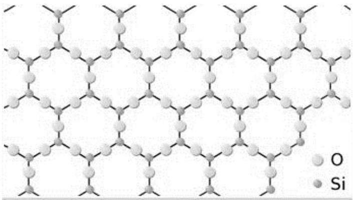
Silicon dioxide (SiO_2)

About 95% of earth crust is made up of silica and silicates .Silicon dioxide is commonly called as silica and it occurs in different forms :

Crystalline form of silica

- Quartz
- Cristobalite
- Tridymite

These forms are inter-convertible at suitable temperature.



Structure of Silicon dioxide

Silicon dioxide is covalent in nature with three dimensional network of solid.

- In which, each Silicon atom is covalently bonded in a tetrahedral manner to four Oxygen atoms.
- Each Oxygen atom in turn is covalently bonded to another Silicon atom.
- Each corner is shared with another tetrahedron.
- The entire crystal is regarded as giant crystal, in which eight membered ring is formed with alternate Silicon and Oxygen atoms as shown below :

Properties

- Silica in normal form is almost non reactive because of high bond enthalpy of Si-O bond.
- Silica is inert.
- Silica has high melting point.
- It doesn't react with halogen , dihydrogen and most of acids .
- It reacts with HF and F_2 as shown :

$SiO_2 + F_2 \rightarrow SiF_4 + O_2$

Silicon dioxide | fluorine | Silicon Tetra fluoride

$SiO_2 + HF \rightarrow SiF_4 + H_2O$

Silicon dioxide | Hydrogen fluoride | Silicon Tetra fluoride

- This silicon tetra fluoride can easily dissolves in HF to form H_2SiF_6 (hydro-Fluoro-silicic acid).
- Due to formation of this compound, the SiO_2 present in glass gets dissolved. That is the reason the hydrogen fluoride can't be stored in glass bottles, instead it is stored in containers made of Cu, Ni+ traces of Fe alloy .
- Quartz is used as piezoelectric material.

Uses

- Silicon dioxide is used as catalyst in petroleum industry.
- When $(NH_4)_2CoCl_4$ is added to silica gel , it act as a humidity detector .Since ,it is blue when dry but turns pink when hydrated .

Silicones

- They are synthetic organo-silicon compounds containing repeated R_2SiO units held by Si-O-Si linkages.
- These compounds have the general formula $(R_2SiO)_n$ where R is methyl or aryl group .

Preparation

- The methyl chloride reacts with Silicon in presence of Copper at temperature 573k.

- As a result, we get different types of methyl substituted cholrosilane of formulas :$MeSiCl_3$, $MeSiCl_2$, Me_3SiCl and also Me_4

$CH_3Cl + Si \rightarrow (CH_3)_2SiCl_2$

methyl chloride dichloromethylsilane

$(CH_3)_2SiCl_2 + H_2O \rightarrow (CH_3)_2Si(OH)_2$

Dichloromethylsilane

- If we carry out hydrolysis of dichlorodi-methylsilane followed by polymerization we get , straight chain polymers

Properties

- Silicones with :
- Short chains - oily liquids
- Medium chain- viscous oils, jellies and greases
- Long chains - rubbery elastomers and resins .
- They are chemically inert, resistant to oxidation and thermal decomposition.
- Silicones are surrounded with non polar alkyl group that are water repelling in nature.
- They are heat resistant and possess high dielectric constant.

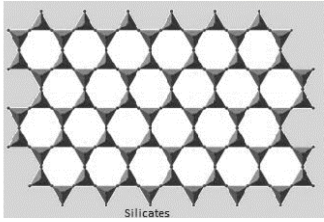
Uses

- They are used in making water proof papers, wool ,textile, wood etc by coating them with thin film of silicones.
- They are used as electric insulators.
- They are used as lubricants at high as well as at low temperature , as there is very little change in their viscosity with temperature.
- They are used in surgical implants.

Silicates

Their basic structural units are SiO_4^{4-}.The important man made silicates are :

- Glass
- Cement



If we look at its structure We observe that these tetrahedrons are linked together by corners and give rise to long chains, ring, sheet or three dimensional structure. The negative charges present are neutralized by positive charges of metal ions.

Zeolites

- They are widely used as catalyst in petrochemical industries for cracking of hydrocarbons.
- In them basically the Silicon atoms in three dimensional structures is replaced by Aluminum ions.
- As a result, the overall structure carries the negative charge .
- To balance this negative charge some cations like sodium ion etc are added in the structure.

For example:

1. ZSM-5 a type of zeolite converts alcohols directly to gasoline.
2. Hydrated zeolite is used as permutit in ion exchange method for softening of hard water.