Difference between organic and inorganic polymers.

Definition

Organic polymers are the polymers that essentially contain carbon atom in the backbon

Inorganic polymers are the polymers that have no carbon atom in the backbone.

Structure

Most organic polymers have simple structures.

Almost all inorganic polymers are highly branched and have complex structures.

Effect on nature

Organic polymers are environmental friendly as these are biodegradable.

Inorganic polymers are not environmental friendly as these are non biodegradable.

Examples

Organic polymers include polysaccharides, proteins, polyesters etc.

Inorganic polymers include silicone rubber, polyphosphazenes etc. NEXT

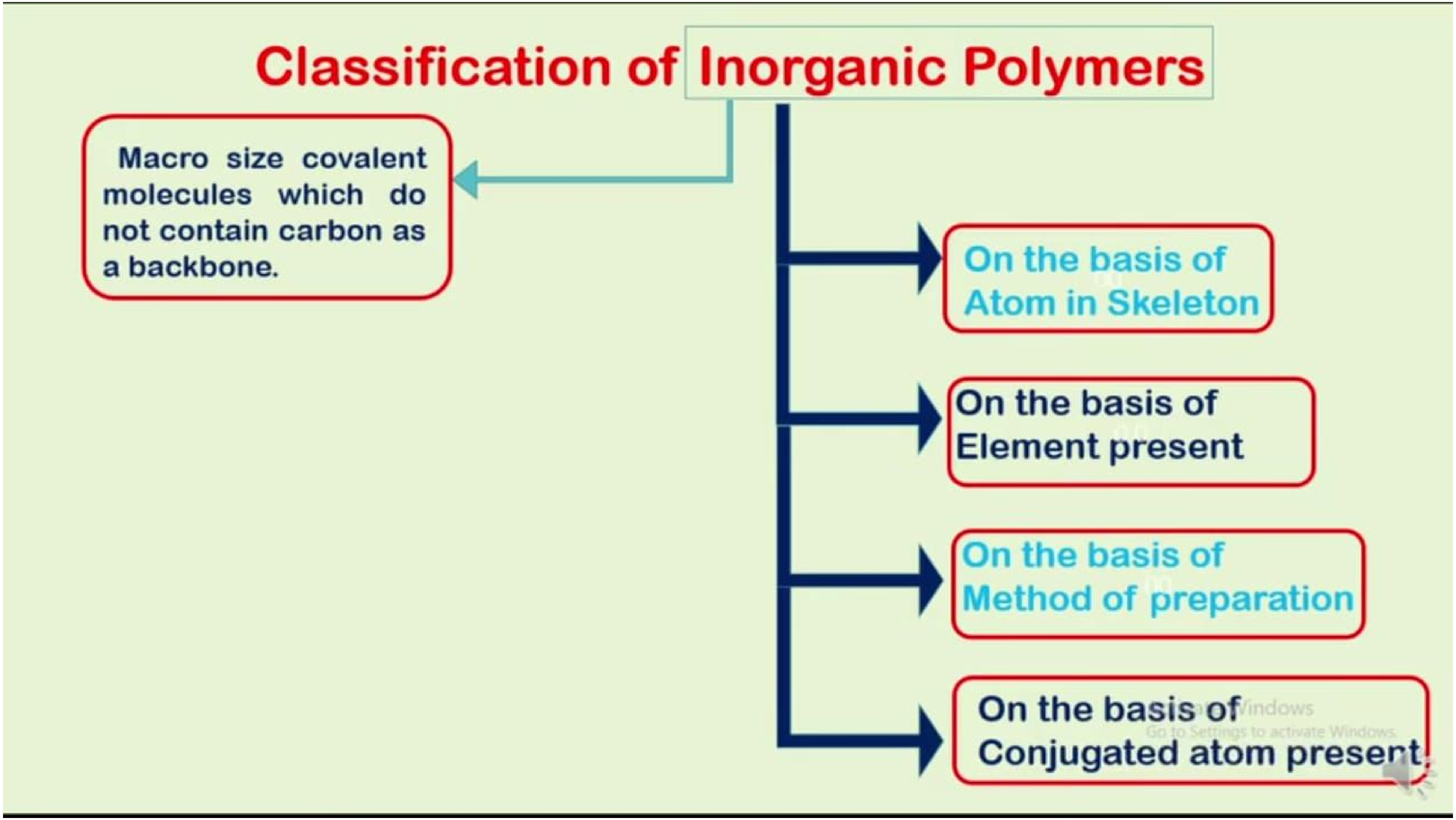
Electrical Conductivity

In most of the aqueous solutions, organic polymers are typically poor conductors of electricity and heat.

Inorganic polymers in aqueous solutions are good conductors of electricity, this is because they have high ability to ionise and this makes them better conductors.

Flammability

Organic polymers are flammable whereas inorganic polymers are nonflammable.


Classification of Inorganic Polymers
Macro size covalent molecules which do not contain carbon as a backbone.
On the basis of Atom in Skeleton
On the basis of Element present
On the basis of Method of preparation
On the basis of Conjugated atom present

On the basis of Conjugated atom present

Conjugated Silicon: Oxygen

- ✓ Silicon and related compounds containing Polymres

Conjugated Phosphorous: Nitrogen

- ✓ Phpshonitrilic halide Polymer $(NPX_2)_n$

Conjugated Sulphur: Nitrogen

- ✓ Metaphosphate, poly phosphate, cross-linked phosphate.

On the basis of Method of preparation

Condensation polymers

- ✓ Two or more similar type of simple molecules polymerised.
- ✓ Elimination of H_2O, NH_3, H_2, HCl molecules.

Addition polymers

- ✓ Addition of monomers.
- ✓ Sulphur trioxide in presence of water gives addition polymer.
- ✓ Propylene react with SO2 in pre. of benzoyl peroxide gives addition polymers

Co-ordination polymers

- ✓ Co-ordinate bond between metal and ligand
- ✓ Chelate containing metal atoms can form such polymers.
- ✓ It can also prepared through elimination-addition reaction

On the basis of Atom in Skeleton

Homo-atomic polymers

- ✓ Only one type of element present
- ✓ i.e. Si, P, Sn, S, Ge

Hetero-atomic polymers

- ✓ More than one type of element present
- ✓ i.e. Silicones

On the basis of Element present

- Boron containing
- Silicone containing
- Phosphorus containing
- Sulphu containi

unit - IV

* Inorganic polymer — Introduction —

→ Inorganic polymer are skeletal structure that does not include carbon atoms in the backbone.

→ polymer containing inorganic & organic components are sometimes called Hybrid polymer & most so called Inorganic polymer are Hybrid polymer.

eg — polydimethyl siloxane, otherwise known commonly silicon rubber.

→ inorganic polymer are metal topology in metal-containing poly

→ Inorganic polymer some properties not found in organic material including low temp. flexibility, electrical conductivity & nonflammability.

→ The inorganic polymer refer generally to one-dimensional polymer, than to Heavily crosslinked material such as silicates minerals.

Classification of inorganic polymer —

① Based on type of atom ⇒ (a) Hetroatomic Inorganic —
These polymer which have different atom & element

→ These polymer have various combination of non-metallic element.

ex ⇒ 3_8 atoms of like Boron, Aluminium, Carbon, silicon, titanium, Hermani Aresenic etc are suitable at x & z position.

(peninsula

(2) portland cement —

— it is least expensive inorganic polymer.
— The term (शब्द) portland is drived (व्युत्पन्न) from the cement having the same colour as the natural stone found in a peninsulla of Britain.
— The word "cementum" ~~[illegible]~~ is a Latin word which means pieces of rough uncut stones.

Constituents of common dry cement —

— Anhydrous Crystalline tricalcium silicate (major) (Ca_3SiO_5)
— Ca_2SiO_4 — β dicalcium silicate.
— lime water — ($Ca(OH)_2$)
— Aluminium silicate — $Al_2(SiO_2)_3$

→ When anhydrous cement is mix with water the react & form Hydrates & Calcium Hydroxide.

$$2Ca_3SiO_5 + 6H_2O \longrightarrow \underset{(70\%\ \text{Hydrates})}{Ca_3Si_2O_7 \cdot 3H_2O} + \underset{(\text{calcium Hydroxide})}{3Ca(OH)_2}$$

→ Harden portland cement contain 70 % crosslinked calcium silicate Hydrates & 20 % Crystalline Calcium Hydroxide.

$$2Ca_2SiO_4 + 4H_2O \longrightarrow \underset{\substack{(70\%) \\ (\text{Calcium silicate Hydrates})}}{Ca_3Si_2O_7 \cdot 3H_2O} + \underset{\substack{(\text{Calcium Hydroxide}) \\ (20\%)}}{Ca(OH)_2}$$

Boro silicate g

(b) Sand glass — These also called heavy glasses. it is substituted by $CaO \longrightarrow PbO$. they are most easily to cut & engraved — giving a product with high lustre

(c) Boro silicate glass —

— 80% silica + 13% Boric oxide + 4% alkali + 2% alumina.
— They are known as Heat shock resistant glass.

— The type & properties of glass can be varried by changes relative amount of nature & gradient

Asbestos —

— Asbestos is term used to refer to six naturally occuring silicate minerals. all are composed of long & thin fibrous crystals. each fiber being composed of many microscopic fibrils than can be realesed in to the atmosphere by abrasion & other process.

· Asbestos is an excellent electrical insulator & Highly resistant to Heat.

Asbestos was used as building material, Howeve it is a well known Health Hazard.
asbestos fibers can lead to various serious lung conditions, including asbestosis & cancer.
Asbestos colour as Green, red, yellow, Whi gray, blue etc.

Difference b/w Diamond & graphite —

Diamond	graphite.
(1) Diamond is a Hardest material.	→ graphite is compaire to diamond it is soft material.
(2) Diamond is a Highly Density material about 3.5 gm/mltr	graphite Density is less about 2.3 gm/mltr.
(3) it is not good lubricate.	→ it is good lubricate.
(4) it is Crystal are octahedral Colourless & transparent in nature.	→ it is black Colour & opaque. it has are Hexagonal Crystal.
In Diamond Carbon each atom Covalently bond along further Corner of tetraHedral	→ In graphite C- atom are bonded together in a flat layer by an strong Covlent bond in regular Hexagonal.
5) Diamond is Hard & strong Covlent bond is present	→ In graphite it atoms are Held together by vander wall force.
) It is non- Conductor of Heat & electricity	→ graphite is good Conductor of Heat & electricity.
it is insoluble in all solvent.	→ It is insoluble in all ordinary solvents.
It has a Crystalline lattice.	→ It has a layered lattice.
C-C bond length in diamond is 154 pm.	→ C-C bond length – 141.5
diamond each Carbon is sp^3 Hybridized.	→ sp^2 Hybridized.

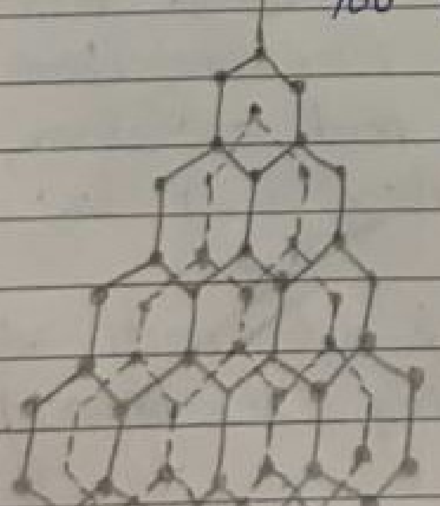
→ Big Diamonds are very rare & are worth a lot of money.
only 20% of diamond are fit for Jwellery & other 80% are of Lower quality. Those lower quality diamond are used industrial purpose.

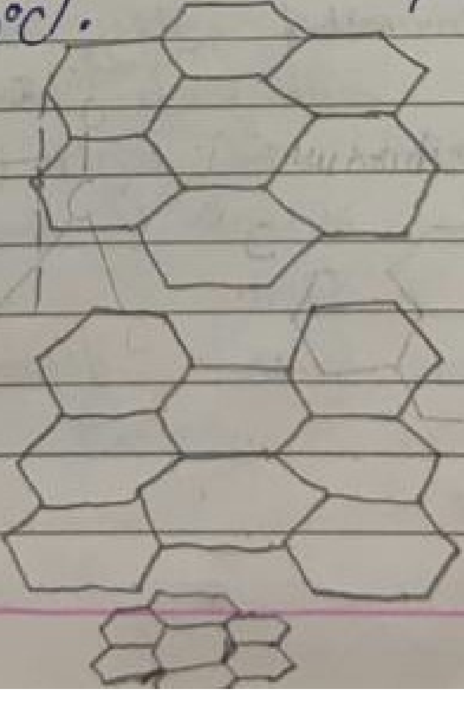
formation of Diamond —

— These are natural & synthetic diamonds. The earth makes natural diamond & people make synthetic diamond.

— Diamond are made of pure Carbon, the same chemical element & graphite & fullerence, & Coal. But diamond are very Hard in Crystalline form.

— Diamond are made deep in the earth where ther is an intense amount of pressure & Heat. The formation of Natural diamond need specific Condit These are exposure of Carbon — bearing materia to light pressure b/w 45 to 60 kilobars. but at a Comparatively low temp. b/w about 900 & 1300°C.





Diamond —

— Diamond is a solid form of the element Carbon with its atom arranged in a crystal structure called diamond cubic.

- A diamond (unbreakable) is a rearrangement of Carbon atoms these are called allotrops.
- Diamond has the Highest Hardness & thermal Conductivity of any natural material, properties that are utilized in major industrial application such as cutting & polishing tools.
- Crystal habit — octaHedral.
- Diamond is a Colorless streak.
- Crystal system — isometric Hex octahedral cubic.

Diamond of a different colours are called "fancies".

- Small number of defect & impurities color diamond blue, yellow, brown & green, purple, pink, organge & red
- Diamond also has Highly ~~re~~ optical dispersion.

The two most common allotrops of pure Carbon are diamond & graphite

- In diamond they are sp^3 & the atoms form tetraHedra with each bound to four neighbors.

tetraHedra are rigid, the bond are strong.

it has the Highest sound velocity & low adhesi & friction.

At room temp, diamond do not react with an chemical reagent including strong acid & base.

— Crystal habit — amorphous, granular, massive etc.

— six mineral types are defined by the EPA as "asbestos", All six asbestos mineral types are known to be Human Carcinogens.

— six types of Asbestos —

(1) Chrysotile asbestos.
(2) Blue asbestos ((rocidolite)
(3) Serpentile asbestos
(4) Amphibole "
(5) Amosite "
(6) Crocidolite "

— Asbestos can be distroyed by ultra – High-temp. incineration.

— A process of thermal decomposition at 1,000–1,250 °C produce a mixture of non-Hazardous silicon based waste & at temp. above 1,250°C it produces silicate glass.

- asbestous specific gravity of 2·4–3·3 & optically its Biaxial.

- SiO_2 chemical composition & physical properties very slowly.
- SiO_2 is viscous liquid & it has optical properties good.
- Glass is made up of mainly SiO_2 & silica & sand.
- it is made up by heating silica & powder additives.

* A typical window glass contain 99 % amorphous SiO_2 + Na_2CO_3 + $CaCO_3$ + Borax (H_3BO_4) with colouring agent.

- Waste SiO_2 (glass) is known as "Cullet"

$$Na_2CO_3 \xrightarrow{\Delta} Na_2O + CO_2$$
$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$
$$H_3BO_4 \xrightarrow{\Delta} B_2O_3$$

There is wide variety of silicon glass. Most sand is is unsuitable for general glass making due to excessive impurities.

formation of different type Glass / SiO_2 —

1) silicon glass — it is made by fusing quartz crystall typically about 99.8 % of SiO_2

m.p of silicon glass is 1750°C.

→ most silicates like polymer can be divided in to these causes —

(a) 3 - dimensional — Tetrahedron geometry
ex — quartz.

(b) layer geometry with stronger bonding within 2-d layer.
ex — mica.

(c) linear structure → ex — Nepherite.

Silicon Dioxide (SiO_2) —

→ SiO_2 is major constituent of rocks & sand & glass also.

→ SiO_2 most commonly found in nature as quartz & in various living organisms.

Notable examples include fused quartz, fumed silica, silica gel & aerogels.

— Density of silicon Dioxide 2.648 gm/cc

— SiO_2 has a number of distinct crystalline forms (polymorphous) in addition to amorphous forms.

— The change in the coordination increase the ionicity of the Si–O bond.

application — Silica used for filtration & cement manufacturing.

— The solubility of silicon dioxide in water strongly depend on its crystalline form.

application — Window glass, electric light bulb, glass-bottle drinking bottle, beakers, & test tube & glass cookware all are SiO_2 containing glass.

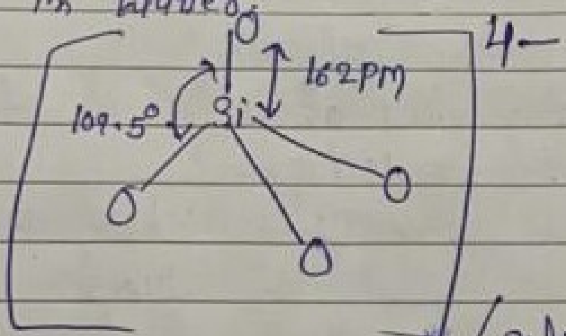
- silicates are extremely important material, both natural & artificial such as portland Cement, ceramics, glass & waterglass.

- silicon atom occupies the center of an Idealized tetrahedron whose corners are four oxygen atoms Connected to it by single covalent bond.

- These tetrahedra may occurs as isolated orthosilicate anions SiO_4^{4-}.

- Solid silicates are generally stable & well characterised

- silicates with alkali cation & small & chain like anions, such as metasilicates, sodium ortho are soluble in water.

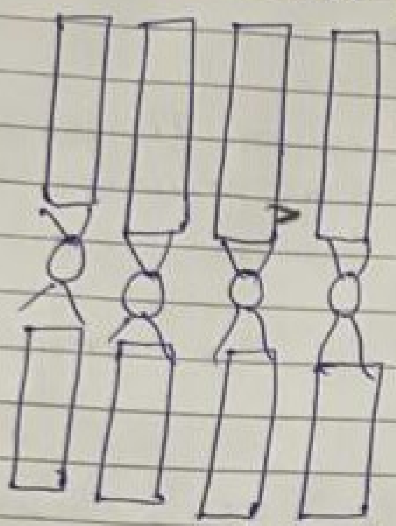


(silicates)

Bonding in silicates —
- for sheet / layer compound bonding is stronger with in sheet rather than in b/w sheet

- Bonding occur through Combination of ionic & Covalent Contribution.
& Back bonding from $e^{\ominus}$ associated with oxygen to vacent orbitals in silicon occur giving Si-O linkage some double & π bond character.

finally $Ca(OH)_2$ begins to crystallize itself formed silicates jungle.



⇛ $Ca(OH)_2$ occupid this void

* original constituent of portland cements.

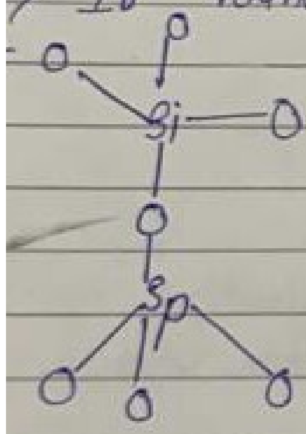
— 60 % Lime (CaO)
— 25 % Silicate
— 5 % Alumina.
— Remaining Fe_2O_3 & Gypsum.

silicates — (SiO_4^{4-})

→ SiO_4^{4-} — ortho silicate.

→ situated in tetrahedron & if two fuses then known ditetrahedron.

→ It found in three forms — chain structure.
— sheet.
— network.



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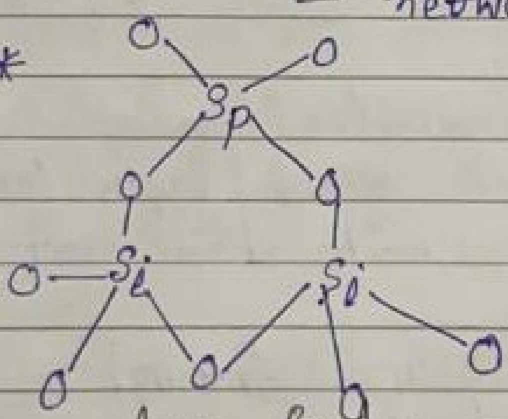


* silicates Depends on two factor — on which pattern it fuses —

(a) It replaces metal ions with similar size.

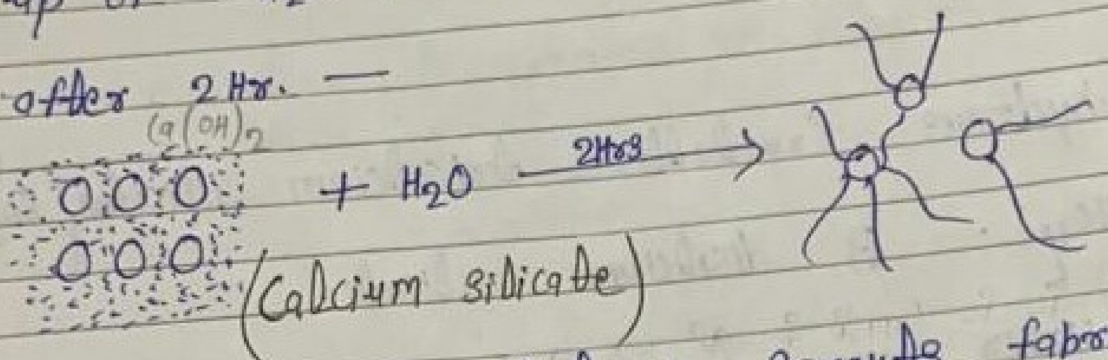
(b) it gives Kaolin & Asbestors.

Harding Cement mechanism —

The Harding cement occurs by two major steps —

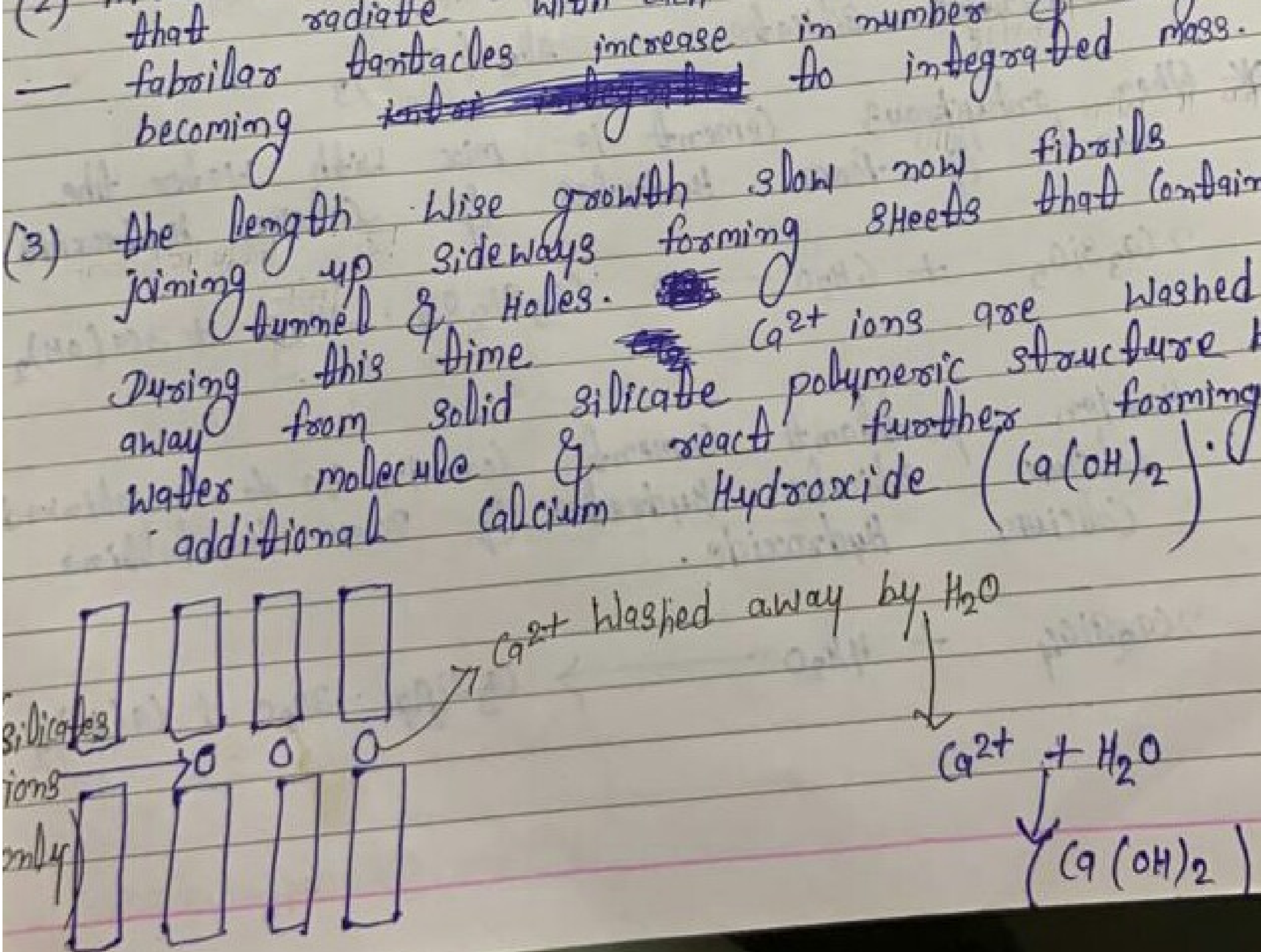
(1) A ~~ta~~ Gelatinous layer is formed on the surface of Calcium silicate particle. The layer is made up of H_2O + Calcium Hydroxide.

after 2 Hr. —



(2) After 2 Hr. The gel layer sprouts fabrilar outgrowths that radiate with each Calcium silicate particle.
— fabrilar tantacles increase in number & length becoming ~~[illegible]~~ to integrated mass.

(3) The length wise growth slow now fibrils joining up sideways forming sheets that contain tunnel & Holes. During this time Ca^{2+} ions are washed away from solid silicate polymeric structure by water molecule & react further forming additional Calcium Hydroxide ($Ca(OH)_2$).



Depending on the amount of water & catalyst present hydrolysis may proceed to completion to silica —

$$\underset{(\text{Catalyst})}{Si(OR)_4} + \underset{(\text{Water molecule})}{2H_2O} \longrightarrow \underset{(\text{silicondioxide})}{SiO_2} + 4R-OH$$

Application of sol gel —

(1) one of the largest app. of sol gel areas is thin film, which can be produced on a piece of substrate by spin coating & dip-coating. protective & decorative coating & electro-optic components can be applied to glass, metal & other type of substrate with these method

(2) the viscosity of sol adjusted in to a proper rang both optical & refractory ceramic fibers, which are used for fiber optic sensor & ther insulation respectively.

3) A sol-gel processed alumina can be used as delivery of drugs & as an established wound healer.

) freeze-casting & freeze gelation.

) mechanics of gelation.

(7) Sol gel —

the sol gel is a method of producing solid material from small molecules.
The method used for the fabrication of metal oxide specially the oxides of silicon & titanium.

Sol gel formation —

— Sol is formed of a gel-like diphasic system containing both a liquid phase & solid phase

— ~~Removal of the~~ These method is to allow time for sedimentation to occur, & then pour off the remaining liquid.

— Centrifugation can also be used to accelerate the process of phase separation.

— Removal of the remaining liquid phase requires a drying process.

(*) The rate at which the solvent can be removed is ultimately determined by the distribution of porosity in the gel.

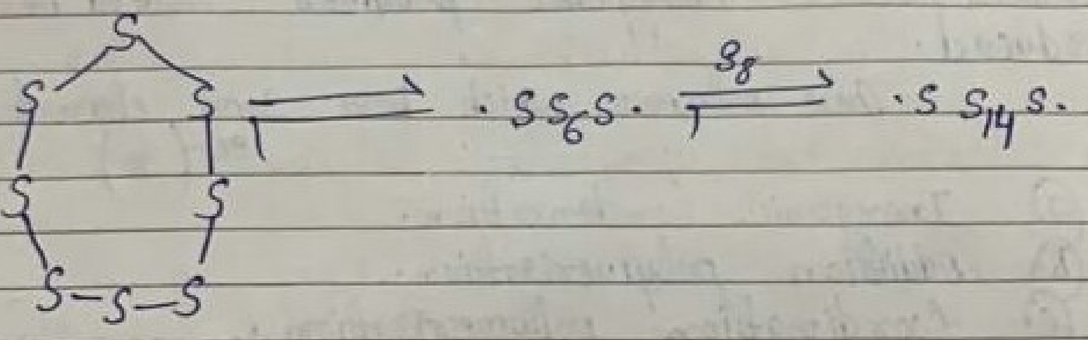
- the sol-gel process is a wet-chemical teq. used for the fabrication of both glassy & ceramic materials.

- The term colloid is used to describe a broad range of solid-liquid mixtures, all of mixture which contain solid particle which are dispersed to in a liquid medium.

The sol gel reaction is called Hydrolysis, because a Hydroxyl ion becomes attached to the silicon atom as follow —

$$Si(OR)_4 + H_2O \longrightarrow HO-Si(OR)_3 + R-OH.$$

These S_8 molecule is heated it gives liquid of low viscosity —



Ⓒ Inorganic Coordination polymer —

- These Coordination polymer are formed by metal & ligand atom.
- its polymer formation of Covlent bond b/w the metal & ligand atom.

ex — $AlCl_3$

Inorganic polymer uses —

— They are used as adhesive & Cutting mate
— Coating.
— flame retardent & fibre extinguisher.
— building Construction material (portland cem & glass)
- lubricants & catalyst ZnO, silicagel. etc -

→ O, N, S are on y position. if y position is more electronegative than C, X & Z are less electronegative than C the stable Heteroatomic inorganic polymer would be produced.

(b) Homoatomic — These polymer which have same element & atom. ex-(S_8)

(2) type of polymerisation —

(a) Inorganic Condensation.
(b) Addition polymerisation.
(c) Coordination polymerisation.

(a) Inorganic Condensation —

— Condensation polymerisation is a form of step growth polym. These are formed by Condensation polymerisation which involves the joining of two & more simple molecule with the elimination of simple molecules (H_2O, NH_3, HCl & H etc.)

example — (a) silicones (b) borazines (c) BN_3
(d) Condensed phosphates etc.

formation of silicones —

$$n\,Cl-\underset{R}{\overset{R}{Si}}-Cl + 2 \cdot H_2O \longrightarrow 2_n\,HCl + OH-\left(\underset{R}{\overset{R}{SiO}}\right)_n$$

(silicones)

(b) Inorganic Addition polymerisation —
These are form by Addition polymerisation — ex → S_8 molecu
— When atom of elemental sulphur atom add S_8 molecule is formed.