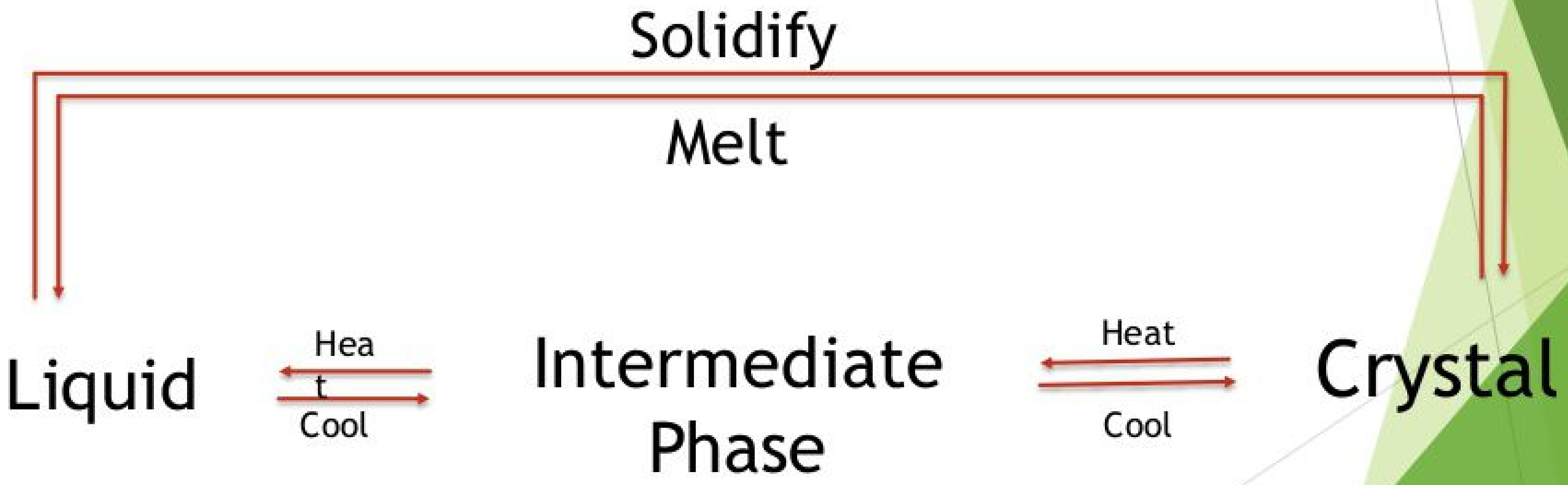
Liquid crystals

- A liquid crystal is a phase between solid and liquid states(phases).



Crystals vs liquid crystals

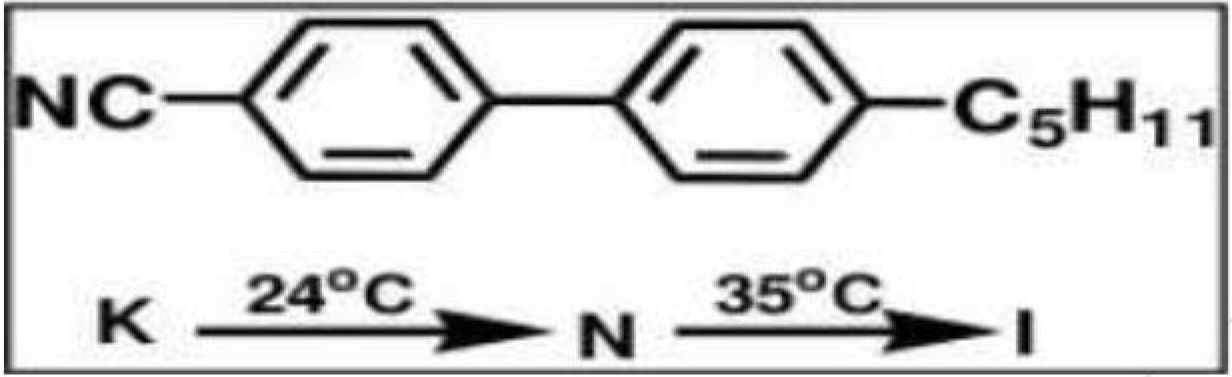
- A crystal is a highly ordered structure which possesses long-range positional & orientational order.
- For many substances these two types of order are destroyed simultaneously when the crystal melts to form a liquid
- For some substances, these orders are destroyed in stages. These are liquid crystals.

A Brief History of LCs

- Liquid crystals was discovered by Reinitzer and Lehmann in 1888.
- Cholesteryl benzoate showed two melting points each. The crystal of this material melted at 145.5 ◦C into a cloudy fluid, which upon further heating to 178.5 ◦C became clear

Cholesteryl benzoate → 145.5 ◦C → 178.5 ◦C

In 1973 the discovery of the most technological and commercial important class of liquid crystals , 4-alkyl-4-cyanobiphenyl. This material found in calculators or mobile phones.

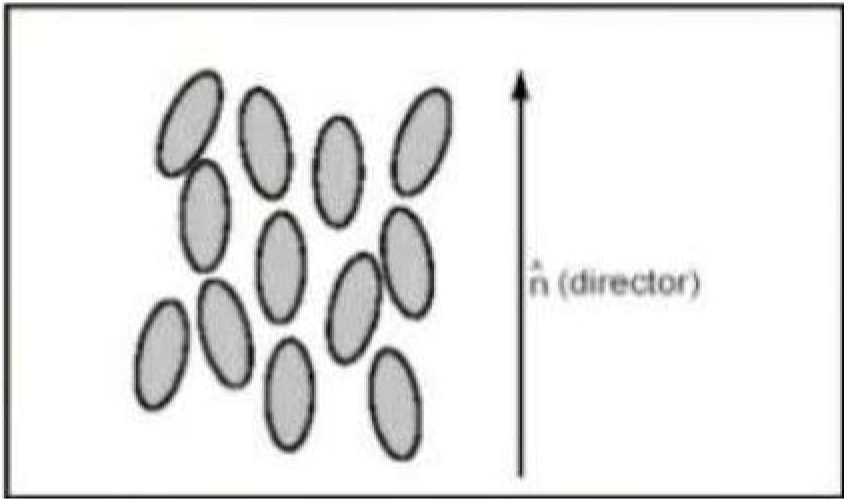


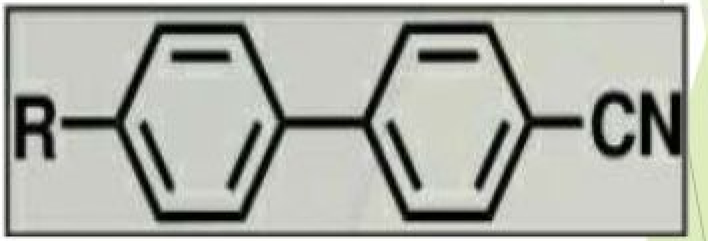
Structural phases of liquid crystals

Nematic

- Nematic drived from the Greek word, ‘nema’ which means “thread”.
- No positional order
- Molecules in same direction
- When temperature is increases molecules will be allign immediately
- In nematic crystal phase molecules are arranged parallel

- Nematic liquid crystals are widely used in electro-optic display devices
- The classical examples of LC displaying a nematic phase is the Cyanobiphenyl





Sematic

- Sematic phase occurs at temperature below nematic or cholesteric.
- Molecules allign themselves approximately parallel & tend to arrange in layers.
- Chiral sematic C liquid crystals are useful in LCDs

Cholesteric

- The first liquid crystal Cholesteric that was observed through a polarising microscope is cholesteryl benzoate. Thus, CHOLESTERIC liquid crystal OR chiral nematic liquid crystal
- E.g. cholesteric benzoate: LC 145C, isotropic 178C
- Cholesteric liquid crystals have great potential uses as
    - Sensors
    - Thermometer
    - Fashion fabrics that change colour with temperature
    - Display devices

Properties of liquid crystals

- Liquid crystal can flow like a liquid, due to loss of positional order.
- Liquid crystal is optically birefringent, due to its orientational order
- Transition from crystalline solids to liquid crystals caused by a change of temperature – gives rise to THERMOTROPIC liquid crystals.
- Substances that are most likely to form a liquid crystal phase at a certain temperature are molecules that are ELONGATED & have some degree of RIGIDITY.

Applications

- Liquid crystals can be found in the following devices:
  - Digital watches
  - Pocket TVs
  - Gas pumps
  - Parking meters
  - Thermal imaging
  - Cell phones
  - Helmets and bullet-proof jacket
  - Digital signs
  - Electronic games
  - calculators

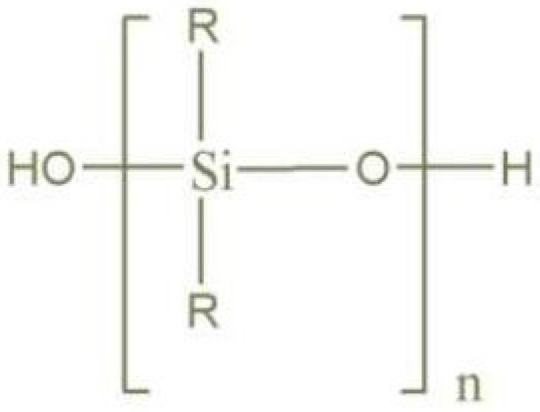
Introduction

- Macromolecules that contain elements other than carbon as part of their principal backbone structure
- In nature-mica, clays, talc etc.
- Typical examples-silicones, silicates, zeolites, phosphazenes etc.

SILICONES

Silicones

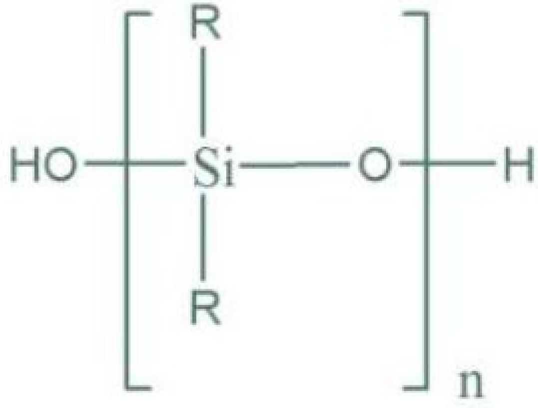
- Synthetic organosilicon polymers containing repeated R_2SiO units held together by Si-O-Si linkages
- <<<<<<<<<<<<<<<<structure



Preparation of silicones

$$2RCl + Si \xrightarrow[573\ K]{Cu\ powder} R_2SiCl_2 + 2H_2O \longrightarrow \underset{\text{Silanol}}{R_2Si(OH)_2} + 2H_2O$$

$$n\, R_2Si(OH)_2 + 2H_2O \xrightarrow{-(n-1)H_2O}$$



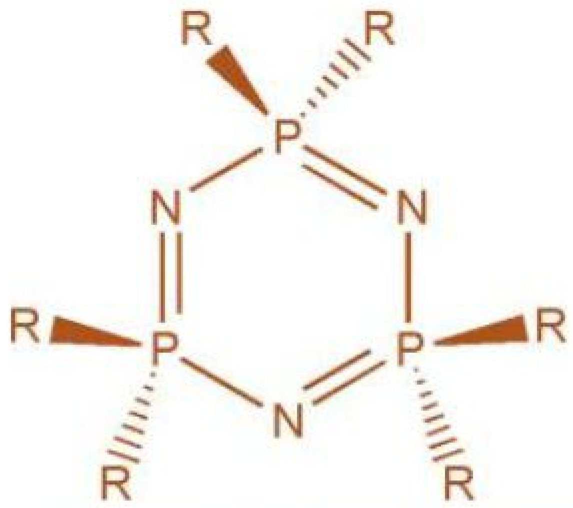
Silicone

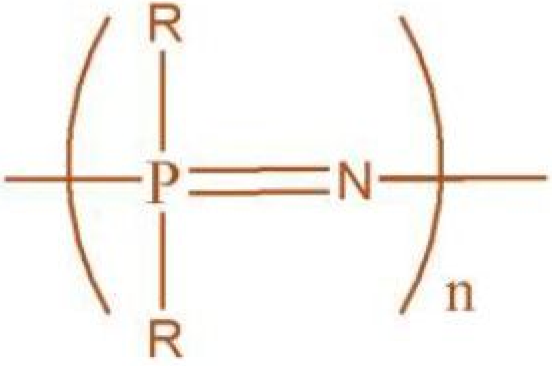
- Straight chain and cyclic forms are possible
- Chain growth may regulated using by adding $(CH_3)_3SiCl$ during hydrolysis
- Hydrolysis of alkyl trichlorosilane gives complex cross-linked polymers

Phosphazenes

Phosphazenes (phosphonitrilic compounds)

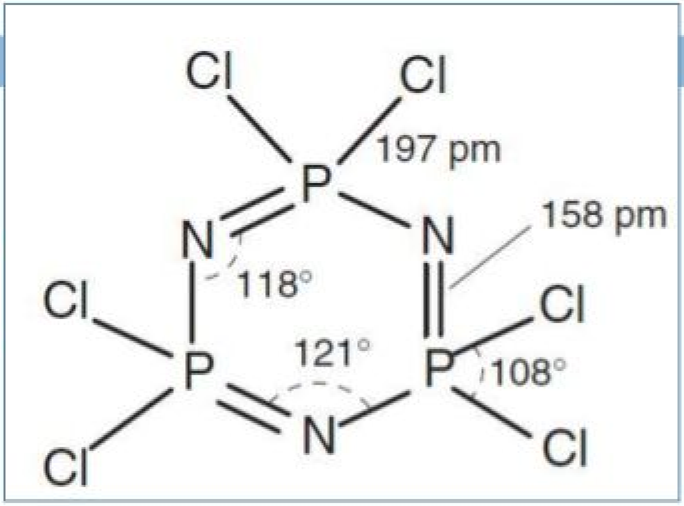
- N in +3, P in +5
- Cyclic phosphazenes and polyphosphazenes

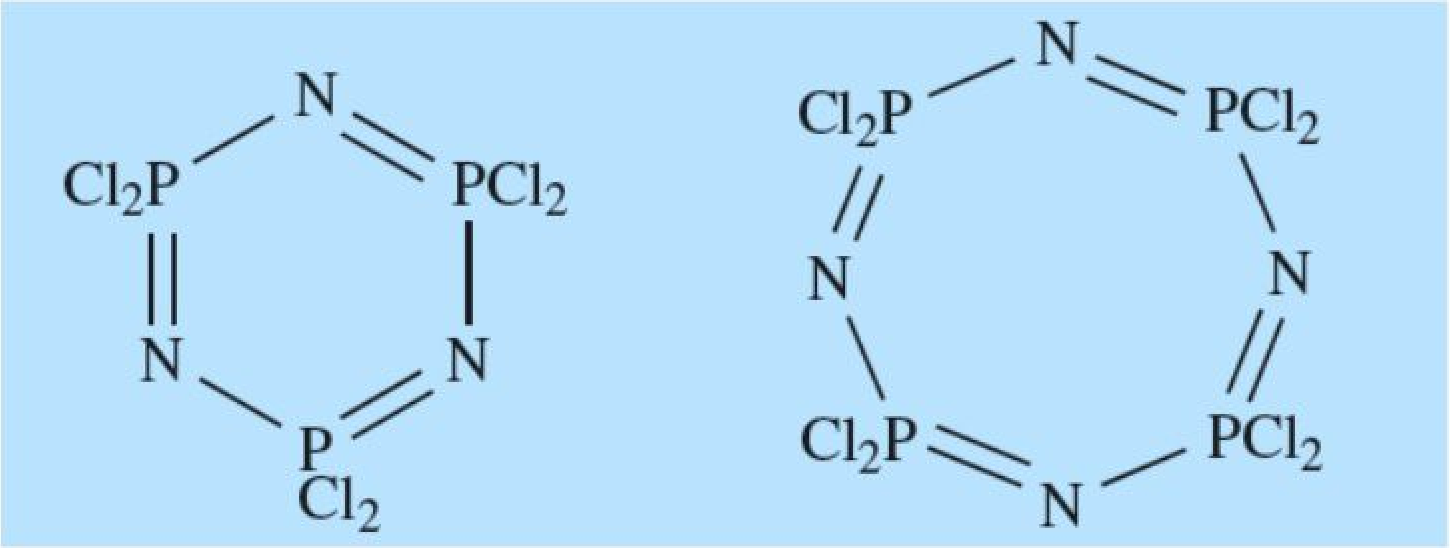




Preparation

$$n\,NH_4Cl + n\,PCl_5 \rightarrow (NPCl_2)_n + 4n\,HCl$$





S-N compounds

S_4N_4

S_2N_2

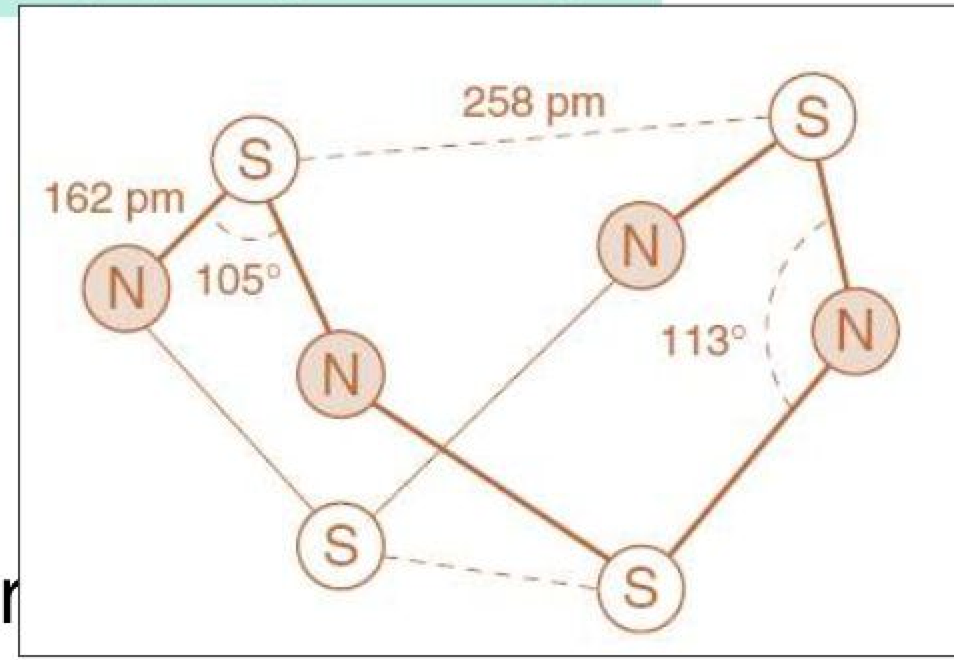
$(SN)_X$

S_4N_4 TETRASULPHUR TETRANITRIDE

- Preparation

$$6\ S_2Cl_2 + 4\ NH_4Cl \rightarrow S_4N_4 + S_8 + 16\ HCl$$

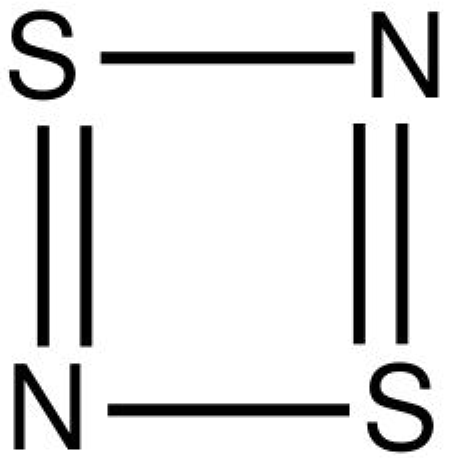
$$6\ S_2Cl_2 + 16\ NH_3 \rightarrow S_4N_4 + S_8 + 12\ NH_4Cl$$



- Cage like cradle structur
- Stable to air-tends to detonate on hammering (decompose to N and S)

S_2N_2 DISULPHUR DINITRIDE

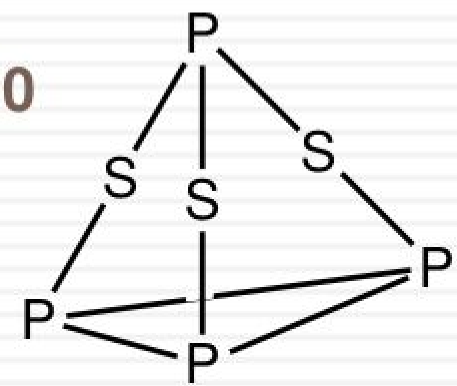
- Preparation
  - $S_4N_4 + 8Ag \rightarrow 4\ Ag_2S + 2N_2$
  - $S_4N_4 + Ag_2S \rightarrow 2\ S_2N_2$
- Structure
- Properties and application
  - Tend to detonate
  - Easily polymerise

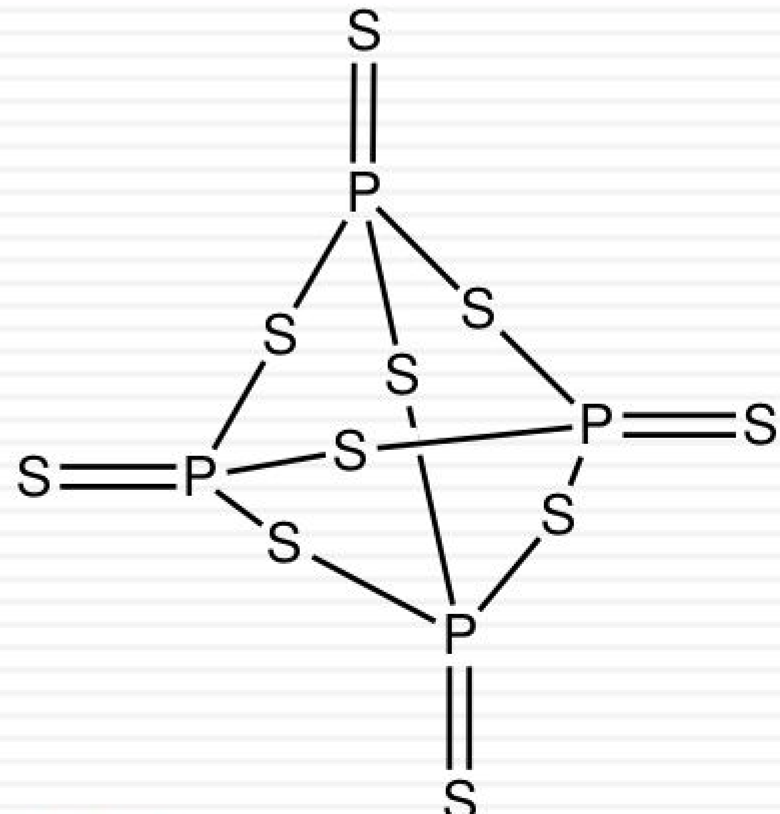


S-P compounds

P_4S_3

P_4S_{10}





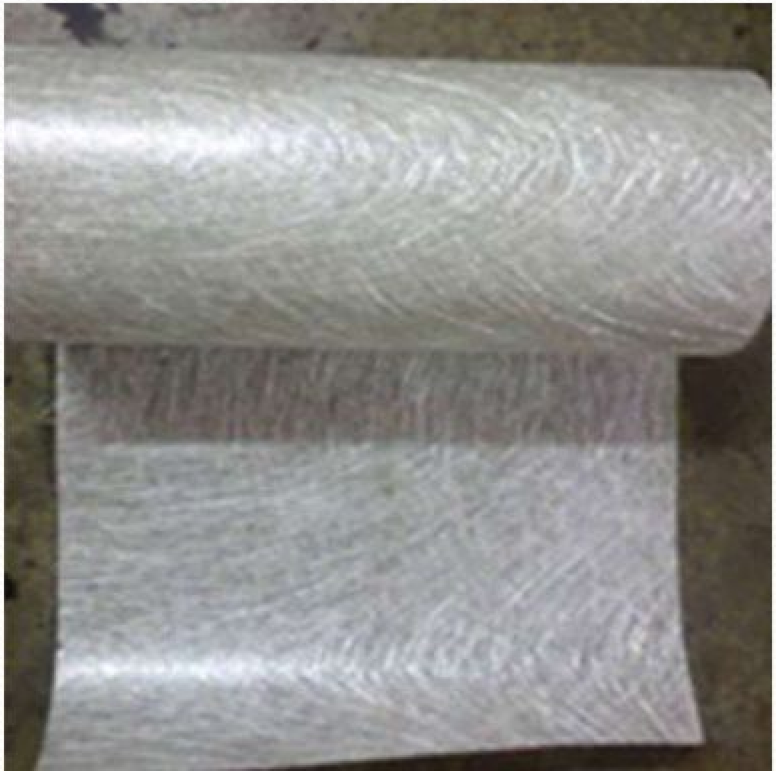
Sulphur-phosphorous compounds

- **P_4S_3**
  - Tetrahedral array of P atoms
  - $P_4 + 3S \rightarrow P_4S_3$ (>100°C)
  - Most stable sulphide of P
  - Used in match industry (P_4S_3 + $KClO_3$ match head)
- **P_4S_{10}**
  - Tetrahedral array of P atoms
  - $P_4 + 10S \rightarrow P_4S_{10}$ (>300°C)
  - Sensitive to moisture (form H_3PO_4)
  - Lawesson's reagent (Anisole + P_4S_{10}) is a thionating agent in org synthesis
  - Production of

FIBERGLASS

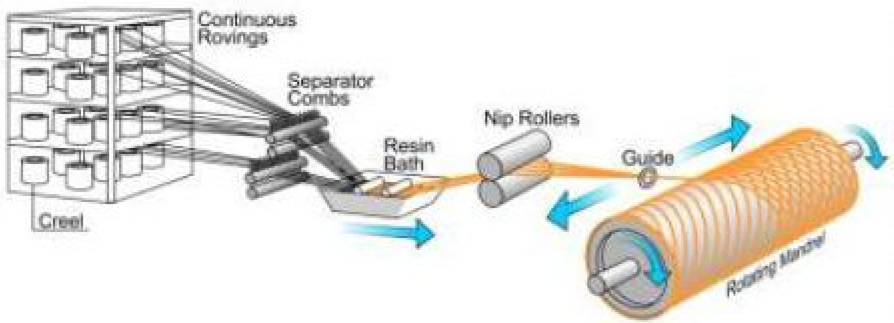
WHAT IS FIBER GLASS

- Fiberglass (or fibreglass) is a type of fiber reinforced plastic where the reinforcement fiber is specifically glass fiber.
- Other common names for fiberglass are glass-reinforced plastic (GRP), glass-fiber reinforced plastic (GFRP)



BACKGROUND

Fiberglass really is made of glass, similar to windows or the drinking glasses in the kitchen. The glass is heated until it is molten, then it is forced through superfine holes, creating glass filaments that are very thin.



fiberglass itself may be manufactured from recycled glass

Originally, fiberglass was a glass wool with fibers entrapping a great deal of gas, making it useful as an insulator, especially at high temperatures.

RAW MATERIAL

The basic raw materials for fiberglass products are a variety of natural minerals and manufactured chemicals. The *major ingredients* are

- **silica sand,**
- **limestone,** and
- **soda ash.**

❖ Silica sand is used as ***the glass former***, and

❖ soda ash and limestone help primarily to lower the melting temperature

Waste glass, also called ***cullet,*** is also used as a raw material.

The raw materials must be carefully weighed in exact quantities and thoroughly mixed together (called batching) before being melted into glass.

TYPES OF FIBER GLASS

The following classification is known:

1. A-glass: With regard to its composition, it is close to window glass

2. C-glass: This kind of glass shows better resistance to chemical impact.

3. E-glass: This kind of glass combines the characteristics of C-glass with very good insulation to electricity.

4. AE-glass: Alkali resistant glass.

PROPERTIES

CHEMICAL RESISTANCE- Fiberglass textile fabrics will not rot, mildew or deteriorate. They resist most acids with the exceptions of hydrofluoric acid and phosphoric acid.

DIMENSIONAL STABILITY- Fiberglass fabrics will not stretch or shrink. Nominal elongation break is 3-4 percent. The average linear thermal expansion coefficient of "E" glass is 5.4 by 10.6 cm/cm/°C.

GOOD THERMAL PROPERTIES- Fiberglass fabrics have a low coefficient of thermal expansion and relatively high thermal conductivity. Glass fabrics will dissipate heat more rapidly than asbestos or organic fibers.

HIGH TENSILE STRENGTH- Fiberglass yarn has a high strength-to-weight ratio. Fiberglass yarn is twice as strong as steel wire.

LOW MOISTURE ABSORPTION-Fiberglass yarn has extremely low moisture absorption.

ELECTRICAL INSULATION- High dielectrical strength and relatively low dielectrical constants make fiberglass fabrics outstanding for electrical insulation purposes.