



**“Dissemination of Education for Knowledge, Science and Culture”  
- Shikshanmaharashi Dr. Bapuji Salunkhe**

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**DEPARTMENT OF CHEMISTRY**

**INDUSTRIAL CHEMISTRY**

**Synthetic Polymer**

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# Synthetic Polymer

## Syllabus

- Introduction.
- Classification of polymers.
- Addition polymerization.
- Ziegler-Natta polymerization.
- Method of preparation and application of organic polymers.
- Conducting organic polymers.
- Application of conducting organic polymers.

# Synthetic Polymer

## Introduction:

**Polymer = Poly + Mer**



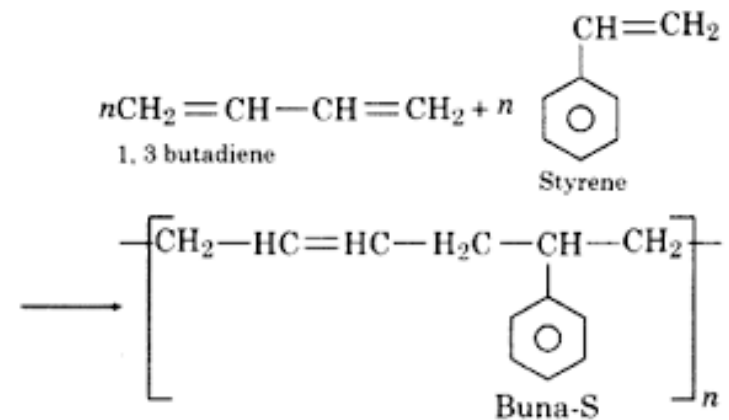
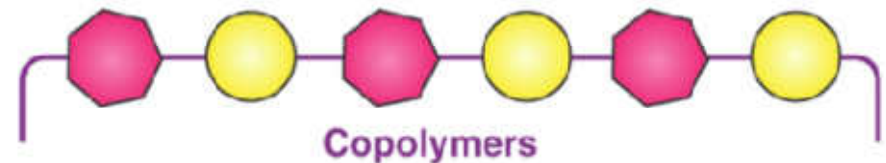
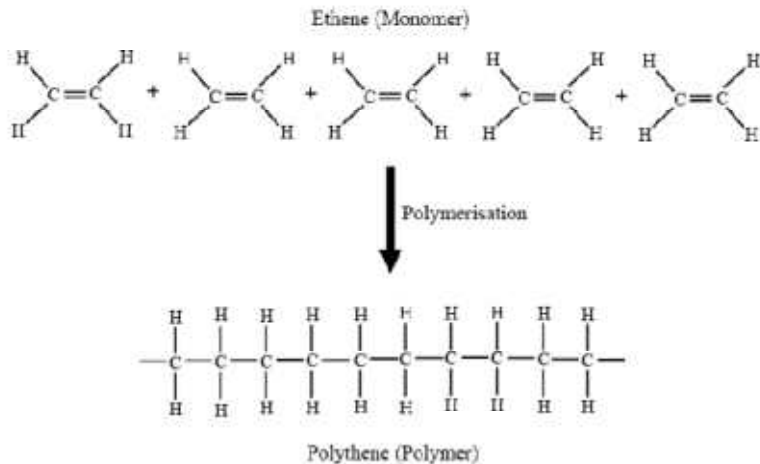
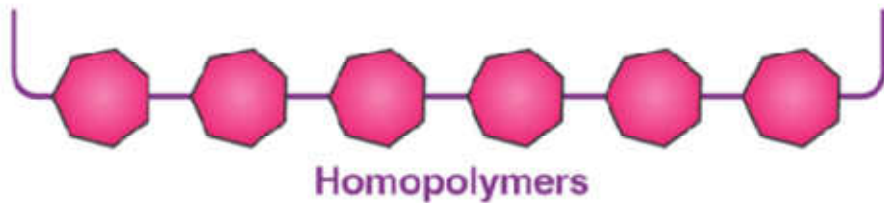
## Polymer:

Any high molecular weight substance or material composed of many repeating subunits are called as Polymer



# Synthetic Polymer

- Monomeric Units (Repeating unit) are the Structural identity repeating itself by several times in polymer molecule
- Number of monomeric units decide the size of polymer molecule
- Polymer molecules are formed by the reaction called polymerization



# Classification of Polymer

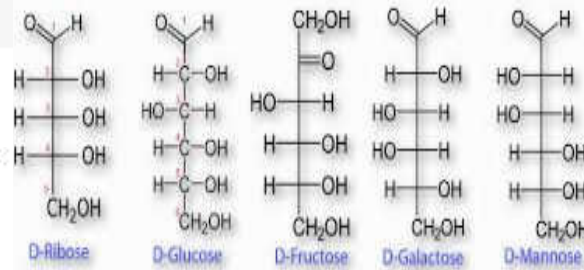
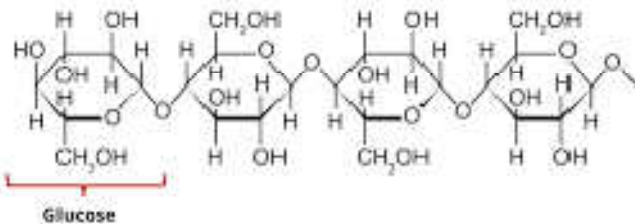
## 1. Based on Origin: Natural Polymers & Synthetic Polymers

### a) Natural Polymers :-

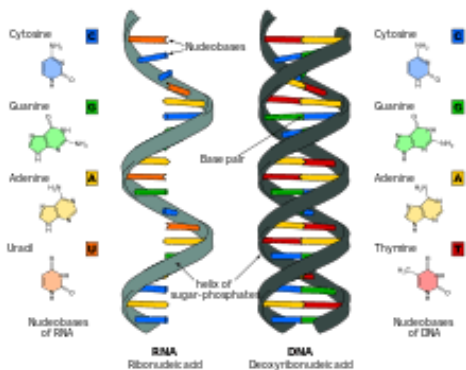
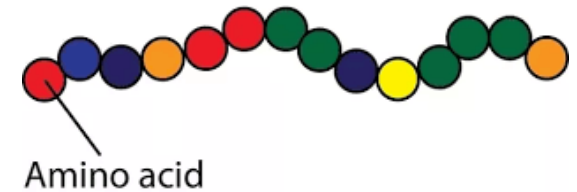
#### CELLULOSE



#### CELLULOSE STRUCTURE

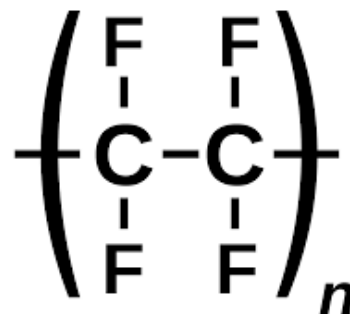
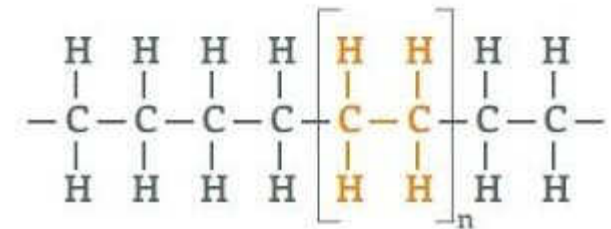
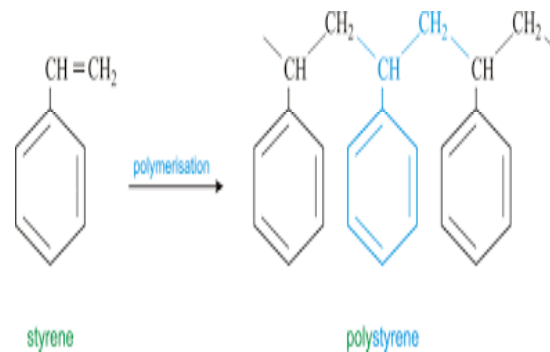
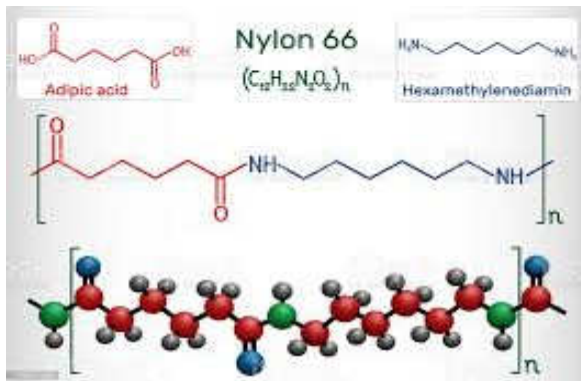


#### Protein



# Classification of Polymer

## b) Synthetic Polymers :-

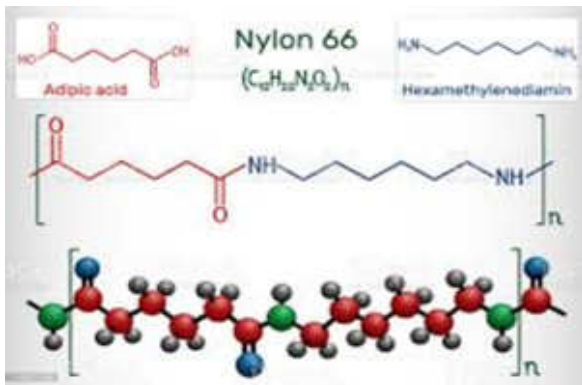
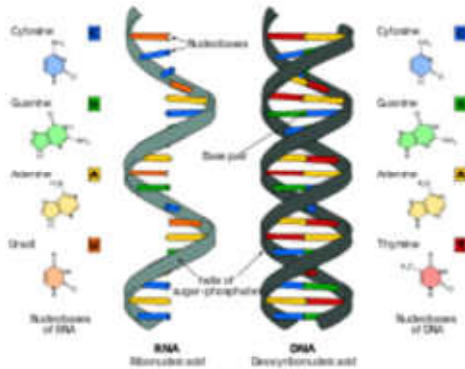


# Classification of Polymer

## 2. Based on Composition:

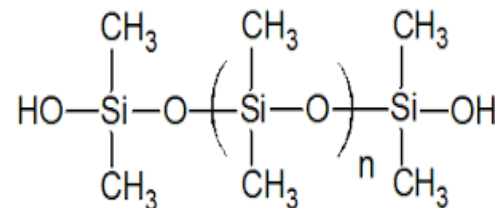
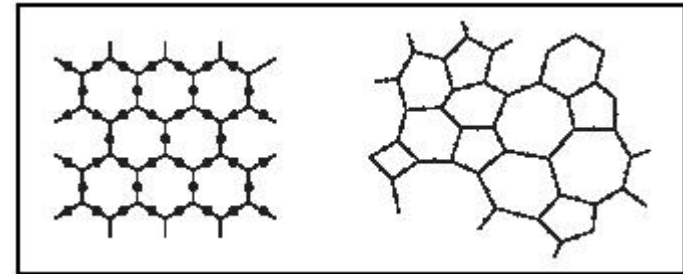
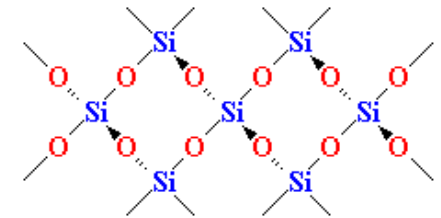
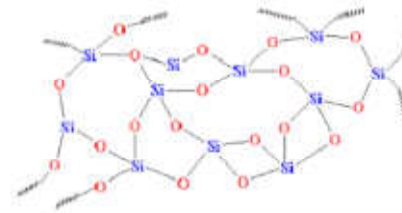
### a) Organic Polymer:

Backbone chain is made of carbon



### b) Inorganic Polymer:

Backbones chain is do not contain carbon



# Classification of Polymer

## 3. Based on Method of Preparation:

### ➤ **Addition Polymer:**

- Polymerization of reaction carried out by addition of monomers (alkenes)
- Empirical formula of polymer is same as that of monomer
- Molecular wt. of polymer = sum of molecular wt. of monomer
- Polymerization is carried out by using catalyst like acid or epoxide
- Ex. Polyvinyl chloride, Polyethylene



# Classification of Polymer

## ➤ **Condensation Polymer:**

- Polymerization of reaction carried out by condensation of monomer  
Condensation of reactive functional groups like COOH, NH<sub>2</sub>, OH etc.
- Elimination of small molecule like H<sub>2</sub>O, NH<sub>3</sub>, CH<sub>3</sub>OH
- Molecular wt. of polymer is less than sum of molecular wt. of monomer
- Ex. Cellulose, Proteins, Nylon 66

# Classification of Polymer

## 3. Based on general physical properties:

### ➤ **Elastomers:**

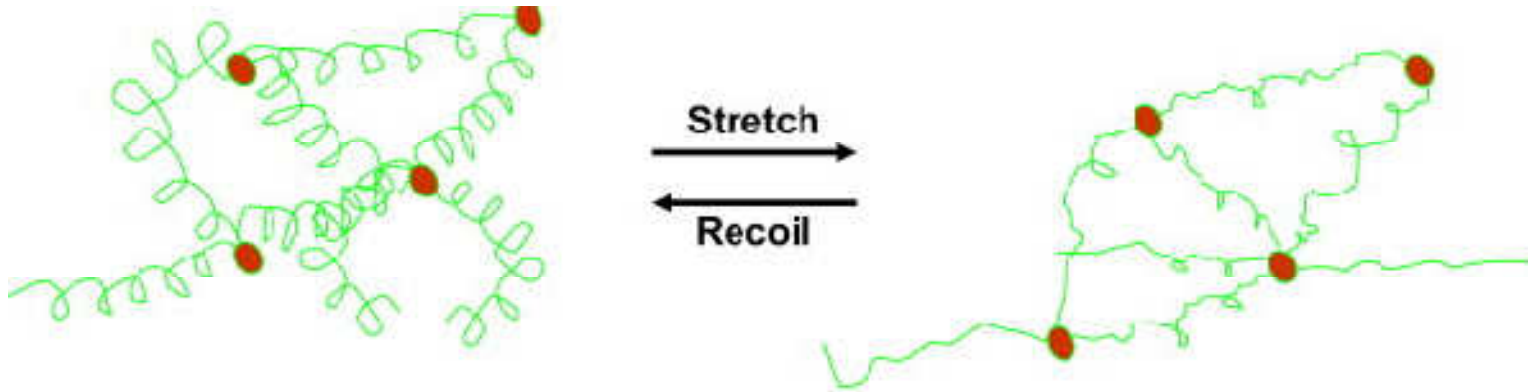
- Polymerization of high degree of elasticity
- General term used to describe rubber or rubber like polymer
- This polymer are greatly deformed by applying stretching force and it regains its original form by removing stretching force
- Do not contain highly polar group for hydrogen bonding
- In unstretched form polymer chain is not properly oriented hence in amorphous forms
- In stretched form polymer chain is properly oriented hence in crystalline form

# Classification of Polymer

## 3. Based on general physical properties:

### ➤ **Elastomers:**

- Polymer chain was held together by weak inter molecular force
- Polymer regain its original position by some cross link between the chain

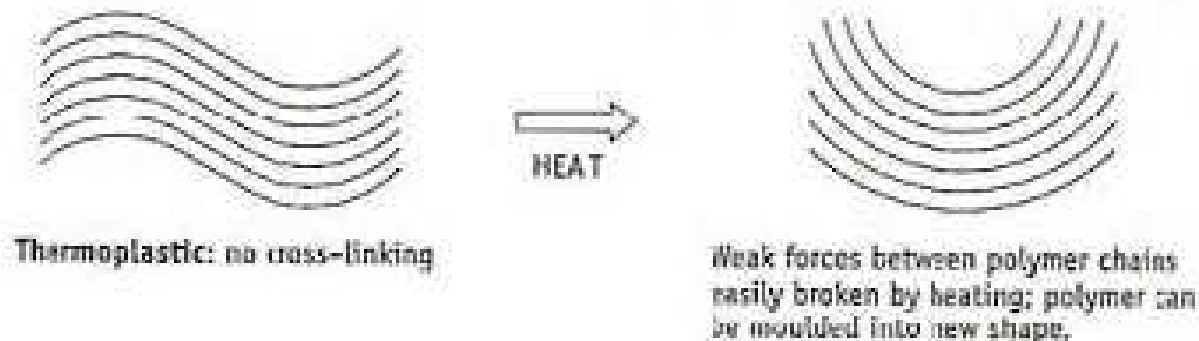


# Classification of Polymer

## 3. Based on general physical properties:

### ➤ **Thermoplastics:**

- Polymer soften on cooling and stiffen on heating
- In soften state it can be molded in any shape which is retained on cooling
- The process of heating, reshaping and retained on cooling can be repeated by several times without change in chemical composition of the polymer
- This property is valuable for recycling of plastic.



# Classification of Polymer

## 3. Based on general physical properties:

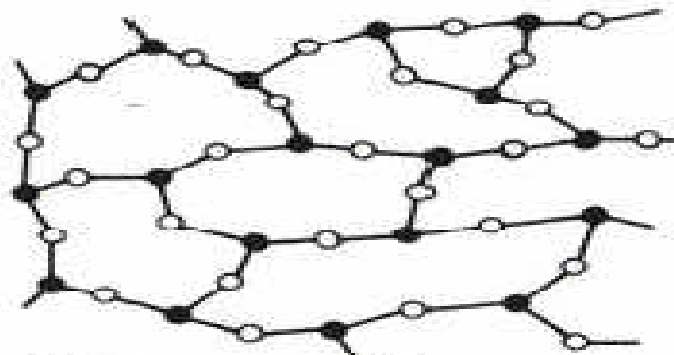
### ➤ **Thermosetting:**

- Polymers which change to an infusible and insoluble mass on heating
- Made from low molecular mass semifluid
- These semifluid polymers on heating form extensive cross linking between different polymer chain to form three dimensional network and convert to insoluble hard mass
- Become permanently hard on heating above critical temperature and will not soften again on reheating because of change in chemical composition (cross linking)
- So they are heated only once and not recycled

# Classification of Polymer



## 3. Based on general physical properties:

### ➤ Thermosetting:



thermosetting  
polymer



THERMOPLASTICS	THERMOSETS
	
(Can be melted repeatedly)	(Once shaped, cannot be melted)

## ❖ **Addition Polymerization:**

- Formed by simple addition of unsaturated monomers
- Unsaturated monomers may be same or different
- Addition polymerization takes place through free radicals or ionic species (electrophile or nucleophile)
- Also called ***chain growth polymerization***

### ➤ **Free radical (addition) polymerization:**

- Unsaturated molecules like alkenes, dienes, and their derivatives undergoes polymerization through free radical



## ❖ Vinyl Polymerization:

- Most of the commercial polymers formed by vinyl polymerization
- Vinyl polymerization obtained from alkenes and their derivatives

Ex.:  $\text{CH}_2 = \text{CH-G}$  where  $\text{G} = \text{H}, \text{Cl}, -\text{CN}, \text{CH}_3, \text{CH}_2\text{Cl}, \text{etc.}$

