Lecture 05: Plastics Properties

1. Plastics

Plastics are commonly known as synthetic resins or polymers. In Greek terminology, *the term polymer comprises 'poly' means 'many' and 'mers' means 'parts'*. Thus, the term, polymer represents a substance built up of several repeating units, each unit being known as a monomer. Thousands of such units or monomers join in a polymerization reaction to form a 'polymer'.

Some natural polymers like starch, resins, shellac, cellulose, proteins, etc are very common in today's use. Synthetic polymers possess several large applications in engineering work. Therefore, *plastic materials are hard and rigid and can be readily molded into different shapes by heating or pressure or both*.

Various useful articles can be produced from them rapidly, *accurately and with very good surface quality*. *They can be easily produced in different colors or as transparent*. They are recognized by their extreme lightness, good corrosion resistance and high dielectric strength. These materials have extensive applications in industrial and commercial work such as electrical appliances, automotive parts, communication products bodies (Telephone, Radio, TV), and those making household goods. They possess a combination of properties which make them preferable to other materials existing in universe.

1.1.Properties of plastics

The properties of plastics are given as under.

1. Plastics are light in weight and at the same time they possess good toughness strength and rigidity.
2. They are less brittle than glass, yet they can be made equally transparent and smooth.
3. They resist corrosion and the action of chemicals.
4. The ease with which they can be mass-produced contributes greatly to their popularity as wrappers and bags.
5. They can be easily molded to desired shapes.
6. They can easily be made colored.
7. They are hard, rigid and heat resistance.

1.2.The structure of polymers

To understand how plastics are made, and why certain plastics are suitable for some uses, and others not, you have to understand a little about the structure of polymers. ***Polymers*** *are large molecules made up of many smaller molecules. 'Poly' means many and 'mer' means units. These smaller units are called* ***monomers*** *(mono = one, mer = unit) and are joined together through* ***polymerisation*** *to form polymers. A polymer contains hundreds of thousands of monomers*.

Polymerisation, which means the linking of monomers to form polymers results from two kinds of chemical reaction called condensation and addition.

The basic structure of plastics (or polymers) is given by macromolecule chains, formulated from monomer units by chemical reactions. Typical reactions for chain assembling are ***polyaddition*** (continuous or step wise) and condensation polymerization (***polycondensation***).

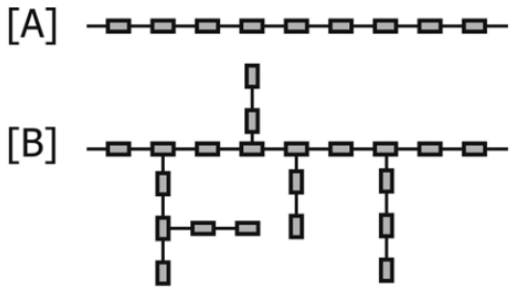
- **Polyaddition as chain reaction**: Process by chemical combination of a large number of monomer molecules, in which the monomers will be combined to a chain. No hydrogen atoms will be moved within the chain during the reaction.
- **Polyaddition as step reaction**: Process by combination of monomer units without a reaction. Hydrogen atoms can change position during the process.
- **Polycondensation**: Generation of plastics by buildup of polyfunctional compounds. Typical small molecules like water or ammonia can be set free during the reaction. The reaction can occur as a step reaction.

1.3.Classification of Plastics

Plastics are broadly classified into thermos-plastics and thermo-setting plastics.

1.3.1. Thermo-Plastics

Those plastics which can be easily softened again and again by heating are called thermoplastic. They can be reprocessed safely. They retain their plasticity at high temperature, i.e. they preserve an ability to be repeatedly formed by heat and pressure.



Structure of thermoplastic types (A) linear and (B) with side chains

Types of Thermo-Plastics

(A) Amorphous

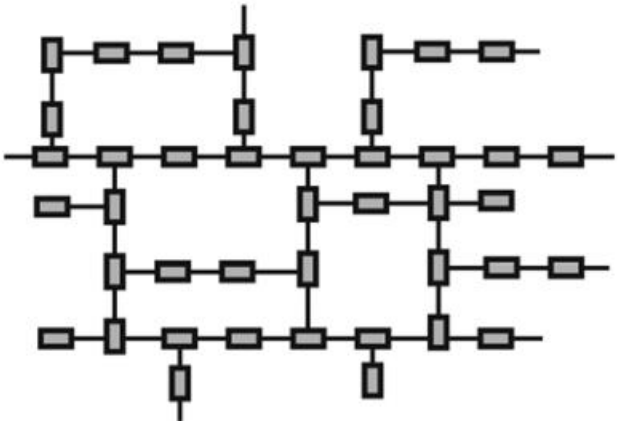
1. Polystyrene
2. P.V.C (Polyvinyl chloride)

(B) Crystalline

1. Polyethylene
2. Polypropylene

1.3.2. Thermo-Setting Plastics

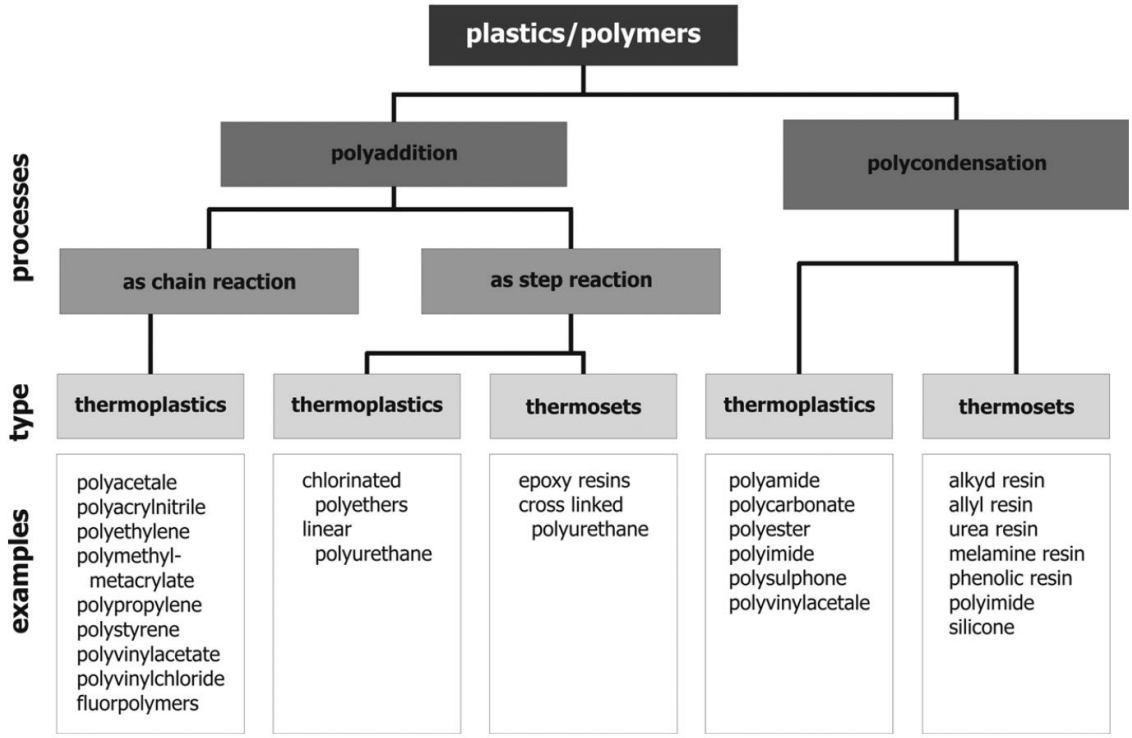
Those plastics which are hardened by heat, effecting a non-reversible chemical change, are called thermo-setting. Alternatively, these plastics materials acquire a permanent shape when heated and pressed and thus cannot be easily softened by reheating. They are commonly known as heat-setting or thermosets.



Structure of strong crosslinking thermosets

Thermosetting resins samples

1. Phenol-formaldehyde resins
2. Polyester resins
3. Epoxy resins
4. Silicone resins



Processes for generating plastics and examples

Comparison between Thermo Plastic and Thermosetting Plastic		
	Thermo-Plastic	**Thermosetting Plastic**
1	They can be repeatedly softened by heat and hardened by cooling.	Once hardened and set, they do not soften with the application of heat.
2	They are comparatively softer and less strong.	They are stronger and harder than thermoplastic resins
3	Objects made by thermoplastic resins cannot be used at comparatively higher temperature as they will tend to soften under heat	Objects made by thermosetting resins can be used at comparatively higher temperature without damage
4	They are usually supplied as granular material	They are usually supplied in monomeric or partially polymerized material form in which they are either liquids or partially thermoplastic solids
5	Themo-plastics can be formed by Injection molding, Extrusion, Blow molding, Thermo-forming, and Casting.	Thermosetting plastics can be formed by Compression or transfer molding and Casting
6	Applications. Toys, combs, toilet goods, photographic films, insulating tapes, hoses, electric insulation, etc.	Applications. Telephone receivers, electric plugs, radio and T.V. cabinets, camera bodies, automobile parts, tapes, hoses, circuit breaker switch panels, etc.

YouTube: https://youtu.be/pOjq4oi0Y40