GLOSSARY OF SELECTED TERMS AND STRUCTURES FOR POLYMERS

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Plastic: is pliable, capable of undergoing deformation, and can be any of a number of organic compounds produced by polymerization.

Polymer: is derived from the Greek word meaning many parts. It is a large molecule built up of repeating, smaller chemical units.

Monomer: is derived from the Greek work meaning one part. They are the smaller, repeating chemical units in a polymer.

Copolymer: is a polymer that consists of two or more monomers.

Natural Polymer: is a polymer that occurs in nature and is extracted. Examples include proteins, cellulose, starches, and rubbers.

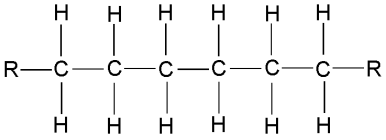
Semi-Synthetic: is a polymer that is extracted from nature and modified by man. Examples include cellulose nitrate, cellulose acetate, and vulcanized rubber.

Synthetic polymer: is a polymer that is man-made. Examples include polyethylene, polyvinyl chloride, and polymethylmethacrylate (acrylic).

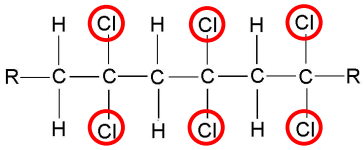
Polymerization: is the chemical process by which monomers form polymers.

Degree of polymerization: is the number of monomeric units in a polymer. It affects the properties of a polymer.

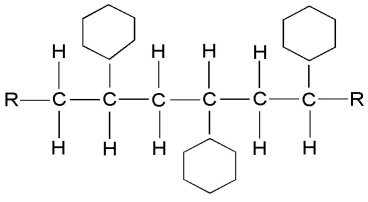
Polyethylene:



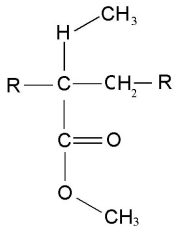
Poly vinyl chloride:



Polystyrene:



Poly methyl methacrylate:



Linear: is a straight chain polymer in which all the carbon to carbon bonds exist in a single line. The chain structure allows for close packing and a higher degree of crystallinity or regular arrangement of the molecule. An example is polyethylene.

Branched: is a polymer chain with branches at irregular intervals. The branching decreases the ability for close-packing and therefore reduces its crystallinity or ability for regular arrangement. An example is low-density polyethylene.

Networked: is a polymer with a long chain, either linear or branched, that can form covalent bonds between the polymer chains. They are generally stronger and more stable polymers. An example is vulcanized rubber.

Intermolecular Forces: are the secondary or weaker forces that encourage molecules to stick together in groups. These are relatively weak bonds that are responsible for holding together linear and branched polymers.

Covalent Bonds: is a bond in which two atoms share electrons. These are relatively strong bonds that are responsible for the cross-links between polymers in networked or thermosetting polymers.

Thermosetting: is a polymer that has cross-linked primary bonds that were formed during polymerization. It will not flow or melt with heat. An example is epoxy.

Thermoplastic: is a polymer that is primarily linear, will soften and melt with heat, and may have secondary cross links that provide strength or rigidity. Examples include polymethylmethacrylate (acrylic), polyvinyl chloride, and polystyrene.

Elastomer: is a polymer, either thermoplastic or thermosetting, that can return to its original size after stretching. An example is rubber.

T_g: Glass Transition Temperature, is the temperature region where the polymer transitions from a hard, glassy material to a soft, rubbery material as the temperature increases.

Chain Scission: is the breakage of the polymer chain between monomers or along the carbon backbone.

Cross Linking are bonds that form from one polymer chain to another or from one side chain to another that are formed during polymerization (primary), a chemical process (vulcanization) or as a result of ageing.

Natural Rubber: is an elastomeric, natural polymer extracted from the latex sap of trees. It is also referred to as India rubber or caoutchouc.

Gutta Purcha: is trans-polyisoprene, a rubber-like substance, that exudes from Malaysian trees of the *Payena* or the *Palaquium* genera.

Vulcanized Rubber: is a semi-synthetic polymer made by exposing natural rubber to heat, pressure, and sulfur. The sulfur creates cross-links in the polymer molecule that make it stronger and more resistant to temperature change. The process was discovered by Charles Goodyear in 1839.

Cellulose Nitrate: is a semi-synthetic polymer made by nitrating the cellulose polymer.

Cellulose Acetate: is a semi-synthetic polymer made by acetylating the cellulose polymer.

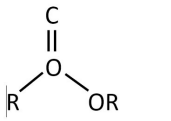
Phenol-formaldehyde: is a thermosetting polymer that is incredibly strong and relatively stable. It was the first synthetic polymer. It has many names, Bakelite being the most common.

Urea-formaldehyde: is a thermosetting polymer made from urea and formaldehyde. Like Bakelite, it is incredibly strong and relatively stable.

Polyvinyl Chloride: is a synthetic, thermoplastic polymer made from the polymerization of the vinyl

chloride monomer. It can have two basic forms, rigid and flexible. The flexible polymer is made through the use of plasticizers.

Polyester: is a synthetic polymer that carries an ester functional group on the main carbon chain. Although more commonly a thermoplastic polymer, it can be made as a thermosetting polymer.



Ester Functional Group

Polymethyl Methacrylate (PMMA or Acrylic): is a thermoplastic, synthetic polymer made from the methyl methacrylate monomer. It is often used in its transparent form as an alternative to glass. It has many trade names that include Plexiglas, Acrylite, Lucite, Perspex, among others.

Polystyrene: is a thermoplastic, synthetic polymer made from the styrene monomer. It can be made as a hard solid or as a foamed plastic.

Polyamide: is a synthetic polymer made from the amide monomer. One of the most well-known polyamides is nylon.

Polyolefins: is a class of polymers produced from an olefin. This class includes polyethylene and polypropylene.

Polyethylene: is a synthetic, thermoplastic polymer made from the ethylene monomer. It is the most widely produced plastic.

Polypropylene: is a synthetic, thermoplastic polymer made from the propylene monomer. It is the second most widely produced plastic.

Polyurethane: is a synthetic polymer composed of organic units joined by urethane links. It is most often a thermoset, but can be made thermoplastic. It can be made as a hard or foamed plastic.

Epoxy: is a class of reactive polymers composed of two components that are mixed together at a specific ratio and cured to a hardened state. Epoxies are thermosetting polymers.

Polytetra-Fluoro Ethylene (Teflon): is a high-molecular weight synthetic polymer composed wholly of carbon and fluorine.It is non-stick and cannot be wet by water. Some of the many uses are as a non-stick coating.

Polycarbonate: is a synthetic, thermoplastic polymer made from the carbonate monomer. It is incredibly strong, tough, easily worked, molded, and thermoformed, and some grades are optically transparent.

Acrylonitrile Butadiene Styrene: is a thermoplastic polymer made by polymerizing styrene and acrylonitrile in the presence of polybutadiene. It is an incredibly strong and tough polymer with high impact and heat resistance. It is also known by its acronym, ABS.

Additives: are materials added to polymers to control their properties. Some of the most common additives include catalysts, stabilizers, flame retardants, fillers, plasticizers, and colorants.

Catalysts: are materials that increase the rate of chemical reactions. If remaining in the polymer after polymerization, they can catalyze degradation.

Stabilizers: are materials used to prevent degradation. Common stabilizers include heat and light stabilizers to ensure safe processing and to protect against aging.

Flame Retardants: are added to combustible materials to prevent or slow the spread of fire. They refer to a function and not a family of chemicals.

Fillers: are added to increase opacity, strength, hardness, and resistance to impact. They are often added to cut costs, but can contribute to a more stable polymer as they are absorptive and there is less polymer to react with.

Colorants: are usually dyes or pigments that are added to change the color of the plastic.

Plasticizers: act to decrease the attraction between polymers contributing to greater flexibility and reduction of brittleness. They will often migrate to the surface as the plastic ages due to improper ratios of plasticizer to plastic or to right a change in equilibrium that has occurred from age.

Spot Tests: are chemical tests performed to test for the presence of a material.

Diphenylamine Test: tests for the presence of nitrates. It is used to identify cellulose nitrate.

Beilstein Test: tests for chlorides. It is used to identify polyvinyl chloride.

Resin Codes: are a system developed in 1988 to assist with recycling of plastics. They are codes from 1-7 that are often printed on the bottom of plastics.

Inherent Vice: is when the materials that comprise an object are responsible for its own self-destruction. An example of this would be cellulose-based polymers with metal components that corrode as a result of the acidic byproducts that are released during degradation.

Vinegar Syndrome: refers to the smell that exudes from degrading cellulose acetate. Cellulose acetate releases acetic acid (vinegar) as it degrades.

Off-gassing: is a process by which gaseous compounds which are the byproducts of chemical reactions are released. Many plastics off-gas as they degrade such as cellulose acetate, cellulose nitrate, and PVC.

Isolation: the process by which a plastic is isolated from other collection objects. It is done to prevent the byproducts of degrading plastics from reacting and causing harm to surrounding collection objects.

Anoxic Storage: it is storage without oxygen. It is intended to slow the degradation of plastics where oxidation is a main source of degradation. It done primarily for natural and vulcanized rubbers.

Cold Storage: it is storage at low temperatures. It is intended to slow the reactions within plastics and therefore slow the rate of degradation. It is often used to help preserve cellulose nitrate and acetate.