Polymers and Plastic Resins Search Form

Search manufacturer catalogs by these specifications:

Material Type / Grade:

- Composite Material
- Thermoplastic
- Thermoset

Chemical / Polymer System Type:

- ABS
- Acetal
- Acrylic
- Epoxy
- Ethylene Copolymer (EEA, EVA)

Filler Material:

- Unfilled
- Aramid Fiber
- Carbon / Graphite
- Fiber Glass
- Metal

Resins & Compounds:

- Pellets
- Liquid

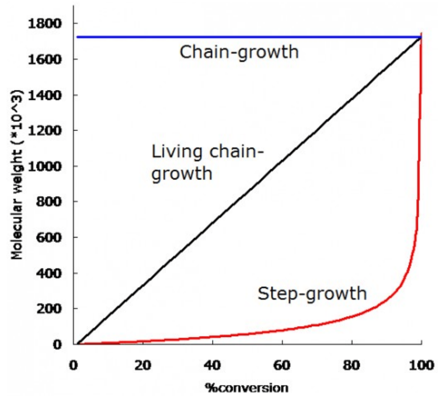
Compound Type:

Polymers and Plastic Resins Information

Show all Polymers and Plastic Resins Manufacturers

Polymers and plastic resins are compounds comprised of two or more repeating organic or synthetic base molecules. They are widely used as raw materials in plastics molding and fabrication operations.

Polymerization



Synthetic polymer chains are formed by reacting two or more organic monomer molecules together. At the most basic level, polymers can be classified into homopolymers, which consist of long chains of the same monomer, and copolymers, which include more than one monomer type. Polymerization can occur by step-growth or chain-growth.

Step-growth polymerization involves the reaction between two different monomer species. It does not require a separate initiator and molecular linking occurs throughout the molecular matrix. Other characteristics of step-growth reactions include a slow increase in molecular weight, the loss of individual monomers early in the reaction, and the fact that the chain ends remain active following the reaction.

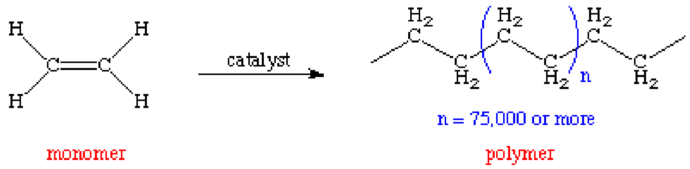
Chain-growth polymerization requires an initiator to form compound carbon bonds, with growth typically occurring at only one end of the chain. Chain-growth features several characteristics which are opposite of those in step-growth reactions, including an early, rapid increase in molecular weight (shown in the graph at right); the permanent termination of chain ends after the reaction; and presence of monomeric materials late in the reaction time.

Production

The plastics industry is divided into two broad sectors: raw material suppliers who produce polymers and resins from intermediates, and processors who convert these materials into finished items. The raw material suppliers use one of the polymerization methods above on either a resin intermediate or monomer in order to produce raw polymers, the products described in this guide.

Raw polymer materials are typically produced and sold in liquid form in the case of adhesives, sealants, and resins; or as bulk pellets, powders, granules, or sheet.

A major source for polymer precursors is petroleum, or crude oil. Processors primarily use cracking techniques to break petroleum hydrocarbons into alkenes such as ethylene, propylene, and butylene, all of which can be polymerized.



Chain-growth polymerization of raw ethylene.

Applications

Plastics are versatile materials and are used to fabricate an enormous array of products. The development of plastics has replaced nearly every other traditional material—including wood, stone, leather, glass, and ceramics—in many applications. The most common uses for plastic include:

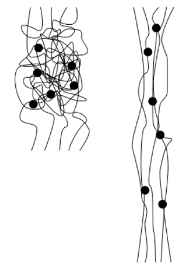
- Packaging: bottles, food packaging, equipment cases

- Building materials: pipes and plumbing, siding
- Automobiles: numerous components
- Furniture
- Toys

Basic Types

Polymer materials can be classified into three broad groups which may overlap. Two of the groups, thermoplastic and thermosetting polymers, are distinguished by curing (or cross-linking) method.

Thermoplastic polymers become more pliable and moldable above a certain temperature and harden or re-harden upon cooling. These polymers form reversible bonds upon cooling, so that cross-linked molecules can be broken and reformed with further heating. For this reason, finished products comprised of thermoplastic materials can be easily recycled and reused.



Thermosetting polymers are irreversibly cured by heat or a chemical catalyst. They typically have higher mechanical strength than thermoplastics but cannot be reused. Thermosetting materials are common in high-strength adhesives and parts used in high-temperature environments, such as automobile components.

Elastomers are polymers with high viscoelasticity; while they are sometimes colloquially known as "rubber," this term technically describes a small group of elastomeric materials. They are typically thermosets and are comprised of carbon, hydrogen, oxygen, and/or silicon monomers. Elastomers are amorphous, meaning they are capable of significant motion and flexibility without fracturing.

The image at right shows an unstressed elastomer (A) and an elastomer under stress (B). Elastomer qualities allow a return to the state shown in (A) after stress is removed.

Common Polymers

A list of common polymers and attributes is shown in the table below. They may be modified by the addition of additives, fillers, and reinforcements, which are used to change their physical and mechanical properties.

Type	Applications	Reaction	Monomer(s)	Cure	Characteristics
Acrylonitrile butadiene styrene (ABS)	Computer monitor cases, pipes	Chain	Styrene, butadiene, acrylonitrile	Thermoplastic	Superior toughness, impact resistance, and heat resistance
Polyethylene	Packaging	Chain	Ethylene	Thermoplastic	Poor temperature and mechanical resistance
Polyester (PET)	Fabrics, packaging, coatings, dielectric use	Step	Ester group	Commonly thermoplastic; thermoset	Poor temperature resistance, good mechanical consistency
Polyvinyl chloride (PVC)	Pipe, insulation, inflatable products	Chain	Vinyl chloride	Thermoplastic	Good temperature and mechanical resistance
Polystyrene	Packaging,	Chain	Styrene	Thermoplastic	Brittle, low melting

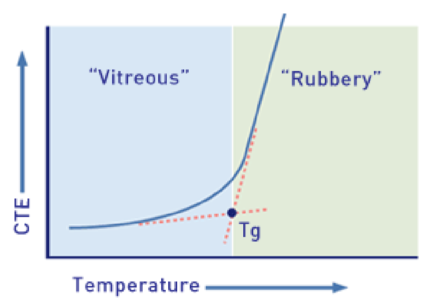
	containers, inexpensive plastics				point
Polyamides (nylon)	Matrix materials, fabrics, parachutes	Step	Amino and carboxylic acids	Thermoplastic	Extremely strong intermolecular forces
Polypropylene	Textiles, packaging, labels, automotive components	Chain	Propene	Thermoplastic	Flexible and resilient
Polyurethane	Insulation panels, potting compounds, adhesives, coatings and sealants	Step	Isocyanates	Mostly thermoset	High temperature and mechanical resistance

Properties and Specifications

A polymer's key properties, including mechanical, electrical, structural, and optical, largely determine its suitability for certain applications. Important properties are discussed below.

Glass Transition Temperature (T_g)

Glass transition temperature, or T_g, is one of the most important polymer product specifications and effectively defines a polymer's behavior at various temperatures. Above T_g, a polymer becomes more elastic and rubbery, while below it the material becomes hard and brittle. In general, polymers with glass transition temperatures above room temperature (approximately 20° C or 70° F) are strong and rigid, while those below are typically elastomers. For example, tire rubber has a T_g of -70° C, while the rigid, tough acrylonitrile butadiene styrene (ABS) has a transition temperature of 105° C.

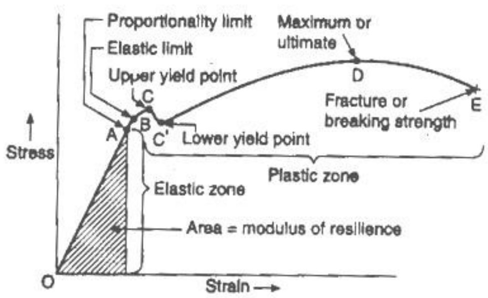


In a chemical sense, glass transition temperature is a measure of the relative mobility of a polymer's molecular chain: specifically, the more immobile the chain, the higher the value of T_g. Other chemical factors which lead to high transition temperatures include strong intermolecular forces, greater cross-linking, and the lack of plasticizing additives.

Mechanical Properties

Mechanical properties are also important polymer characteristics. These serve as good indicators of a polymer's behavior under stress, including its strength, stiffness, brittleness, hardness, and resilience to repeated stress.

All of these properties can be easily illustrated using a stress-strain curve like the one above. Stress is defined as the force per unit area of the sample, while strain is the measure of the change in sample length. By using a tension meter, a stress-strain curve can be plotted to show the ratio between the two properties. Tensile strength and Young's modulus, which are explicitly labeled in the image above, are identified by (E) and the shaded area, respectively.



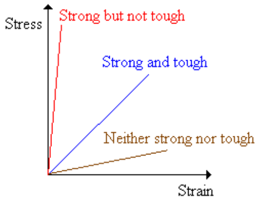
Tensile strength (E) is the stress required to break a sample. Polymers expected to be stretched must have good tensile strength. This property is expressed in Pascals or psi.

Percent elongation-to-break represents the strain on a sample at its breaking point, expressed as a percent. Elastomers have particularly high elongation-to-break value.

Young's modulus (shaded area) is the slope of a stress-strain curve. Rigid materials typically have high modulus, while elastomers have low values.

Toughness is the area below the stress-strain curve and represents a measure of the energy a sample can absorb before fracturing.

"Toughness" and "strength" are different properties. A sample which is strong but not tough is often referred to as brittle and can withstand high stresses under low strain. A material which is neither strong nor tough fractures under low stress at relatively low strain. See the graph at right for illustration of this principle.



Other Properties

Other polymer properties are helpful when considering materials for specific applications. Some of these property groups are listed below.

- Volumetric and calorimetric properties
- Surface properties
- Permeability
- Electrical properties: dielectric strength, dissipation power, magnetic properties
- Optical properties: refractive index, molar refraction
- Material stability

Standards

Raw polymers may be produced, tested, and employed based on published standards and specifications. ASTM International, for example, maintains an entire section of standards covering standard property test methods, environmental safety, and recycling plastics. Most plastics standards are specific to the polymer makeup listed in the table above.

Example standards include:

- ISO 1872-2 Polyethylene (PE) moulding and extrusion materials: Preparation of test specimens and determination of properties
- ASTM D747 Standard test method for apparent bending modulus of plastics by means of a cantilever beam
- ASTM D4092 Standard terminology for plastics: Dynamic mechanical properties

References

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