



POLYBAGS
part of the PB Group

Lyon Way, Greenford,
Middlesex, UB6 0AQ

T. 0345 200 2828

www.polybags.co.uk

POLYBAGS GUIDE TO PLASTICS

HOW PLASTICS ARE MADE

Plastic: Any of various complex organic compounds produced by polymerization, capable of being molded, extruded, cast into various shapes and films, or drawn into filaments used as textile fibres.

-- Webster's Dictionary

THE BASICS

The term "plastics" encompasses organic materials, such as the elements carbon (C), hydrogen (H), nitrogen (N), chlorine (Cl) and sulfur (S).

The plastic production process begins by heating the hydrocarbons in a "cracking process." Here, in the presence of a catalyst, larger molecules are broken down into smaller ones such as ethylene (ethene) C₂H₄, propylene (propene) C₃H₆, and butene C₄H₈ and other hydrocarbons. The yield of ethylene is controlled by the cracking temperature and is more than 30% at 850°C and such products as styrene and vinylchloride can be produced in subsequent reactions. These are then the starting materials for several other types of plastics. Therefore, this process results in the conversion of the natural gas or crude oil components into monomers such as ethylene, propylene, butene and styrene.

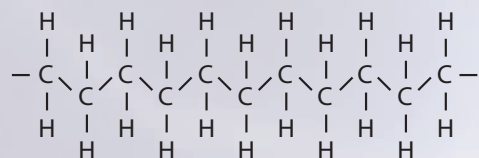
These monomers are then chemically bonded into chains called polymers. Different combinations of monomers yield plastic resins with different properties and characteristics. Each monomer yields a plastic resin with different properties and characteristics. Combinations of monomers produce copolymers with further property variations.

The resulting resins may be moulded or formed to produce several different kinds of plastic products with applications in many major markets. The variability of resin permits a compound to be tailored to a specific design or performance requirement. This is why certain plastics are best suited for some applications while others are best suited for entirely different applications. For instance, impact strength measures the ability of a material to withstand shock loading. Heat resistance protects the resin from exposure to excessive temperatures. Chemical resistance protects the resin from breakdown due to exposure to environmental chemicals.

THE STRUCTURE OF POLYMERS

Polymers are created by the chemical bonding of many identical or related basic units and those produced from a single monomer type are called homopolymers. These polymers are specifically made of small units bonded into long chains. Carbon makes up the backbone of the molecule and hydrogen atoms are bonded along the carbon backbone.

Polymers that contain primarily carbon and hydrogen are classified as organic polymers. Polypropylene, polybutylene, polystyrene, and polymethylpentene are examples of these. Below is a diagram of polyethylene, the simplest polymer structure.



Even though the basic makeup of many polymers is carbon and hydrogen, other elements can also be involved. Oxygen, chlorine, fluorine, nitrogen, silicon, phosphorous, and sulfur are other elements that are found in the molecular makeup of polymers. Polyvinyl chloride (PVC) contains chlorine. Nylon contains nitrogen. Teflon contains fluorine. Polyester and polycarbonates contain oxygen. There are also some polymers that, instead of having a carbon backbone, have a silicon or phosphorous backbone and these are considered inorganic polymers.

ar bags, large clear bags, self seal bags, slider, printed grip bags, basic mailing bags, special mailing bags, ca
bble products, carrier bags, waste sacks, specialist bags, rolls of polythene, selaers and shrinkers, useful acc
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y style bubble line paper envelopes, artist and florists clear polythene, pedal and swing bin liners, brown and

THE ADDITIVES

When plastics emerge from reactors, they do not have the desired properties that make it a material of choice, that is, it is considered a raw material. In order to achieve a commercial product, the plastic is subject to further treatment and the inclusion of additives which are selected to give it specified properties. Most polymers are blended with additives during raw material processing into their finished parts. Additives are incorporated into polymers to alter and improve their basic mechanical, physical or chemical properties. Additives are also used to protect the polymer from the degrading effects of light, heat, or bacteria; to change such polymer properties as flow; to provide product colour; and to provide special characteristics such as improved surface appearance or reduced friction.

Examples of types of Additives:

- antioxidants: for outside applications
- colourants: for coloured plastic parts
- foaming agents: for styrofoam cups

TWO CHARACTERISATIONS OF PLASTIC

A **Thermoset** is a polymer that solidifies or "sets" irreversibly when heated. Similar to the relationship between a raw and a cooked egg, once heated, a thermoset polymer can't be softened again and once cooked, the egg cannot revert back to its original form. Thermosets are valued for their durability and strength and are used primarily in automobiles and construction, although applications such as adhesives, inks, and coatings are also significant. Other examples of thermoset plastics and their product applications are:

Polyurethanes:

- mattresses, cushions, insulation, ski boots, toys

Unsaturated Polyesters:

- lacquers, varnishes, boat hulls, furniture

Epoxies:

- glues, coating for electrical circuits, helicopter blades

A **Thermoplastic** is a polymer in which the molecules are held together by weak secondary bonding forces that soften when exposed to heat and return to its original condition when cooled back down to room temperature. When a thermoplastic is softened by heat, it can then be shaped by extrusion, molding or pressing. Ice cubes are a common household item which exemplify the thermoplastic principle. Ice will melt when heated but readily solidifies when cooled. Like a polymer, this process may be repeated numerous times. Thermoplastics offer versatility and a wide range of applications. They make up the greatest share of plastics used in food packaging because they can be rapidly and economically formed into any shape needed to fulfil the packaging function. Examples are as follows:

Polyethylene:

- packaging, electrical insulation, milk bottles, packaging film, agricultural film

Polypropylene:

- carpet fibres, automotive bumpers, microwave containers, external prostheses

Polyvinyl chloride (PVC):

- floor and wall coverings, credit cards, car instrument panels

PROCESSING METHODS

There are a variety of different processing methods used to convert resins into finished products. Some include:

Extrusion - This continuous process is used for the production of semi-finished goods such as films, sheet profiles, tubs and pipes. They are termed "semi-finished" because they must be further processed before they become useful articles. Plastic material is first loaded into a hopper and then fed into a long heated chamber through which it is moved by the action of a continuously revolving screw. At the end of the heated chamber, the molten plastic is forced out through a small opening called a die that is cast in the shape of the finished product. As the plastic extrusion comes from the die, it is cooled by blowers or by immersion in water. Examples of products include pipe, film and window trim.

Injection moulding - Since this process can produce mouldings of high quality and with great accuracy, it is very widespread. It is predominately used for thermoplastics but smaller amounts of thermosets and elastomers are also processed this way. In injection moulding, plastic material is also put into a hopper, which feeds into a heating chamber. A plunger pushes the plastic through the heating chamber where the material is then softened into a fluid state. At the end of this chamber, the resin is forced into a closed mould. Once the plastic cools to a solid state, the mold opens and the finished product is ejected. This process is used to make such items as butter tubs, yogurt containers, closures, fittings and razors.

Blow moulding - Blow moulding is a process used in conjunction with extrusion. The die forms a molten tube of thermoplastic material. Using compressed air, the tube is then blown to conform to the interior of a chilled mould which clamps around the tube. Overall, the goal is to produce a uniform melt, form it into a tube with the desired cross section and blow it into the exact shape of the product. This process is intended for use in manufacturing hollow plastic products and its principal advantage is its ability to produce hollow shapes without having to join two or more separately molded parts. This method is used to make items such as commercial drums and bottles.