Lecture No. (5)

Applications and Types of Elastomer Materials

Elastomer Applications

The natural and synthetic rubbers are widely used for various applications, because of their unusual and useful properties that are unmatched by other types of materials, such as high elasticity, extensibility, resiliency, durability, high abrasion resistance, high strength and other properties,

The synthetic rubber is used to manufacturing most types of rubber products, but natural rubber is represented the basic constituent of some rubber products, therefore the rubber materials using in many fields which includes:

1- Industrial Products: such as rubber bands, fuel resistant parts, electrical insulation, drive belts, conveyor belts, floor coverings, elevator belts, rafts, foam rubber, hoses, tubes, paints, fertilizer and bridge bearings.
2- Sporting Field: such as golf balls, bowling balls, football balls, sporting goods and toys balloons.
3- Medical Field: such as catheters, gloves, surgical purposes, medical implants and medical equipment.
4- Costumer Products: such as raincoats, sponges, pencil erasers, soap, shoes, and adhesives.
5- Seismic Materials: for example (over 2,500 buildings are respectively fitted with seismic rubber bearings in China and Japan).
6- Transport Field: the essential uses of rubber in the transportation such as automotive (truck or bus) tires, bicycles tires and aircraft tires. Most commonly, tires consist of both natural rubber and synthetic rubber. Natural rubber has a greater resistance to heat compared to synthetic rubber, therefore tire products account for more than 50% of natural rubber and the tire manufacturing is the world's largest consumer of natural rubber.

Industrial Applications of Elastomer Materials

1- Gaskets

Gaskets are mechanical seals that fill the space between imperfect mating surfaces. The elastomer type to be employed will depend on a variety of

factors such as service temperature, mechanical properties, environmental properties which includes: (weathering/ozone/UV) and chemical resistance to acids, salt, water, oils, and fluids.

2- Seals

Similar to gasket applications, elastomers are heavily utilized as seal in the industrial machinery, find two types of seals are hydraulic seals and pneumatic seals. Hydraulic seal uses to prevention of fluid leakage, this type of seals use elastomers withstand to high pressures, high temperature and flexural forces. While, the pneumatics seals use elastomers withstand to lower pressure.

3- Noise Reduction & Dampening

Many elastomer materials using to reduce both vibration and noises, also uses to dampen natural sound and airborne sound over a broad temperature and frequency. The best example of this application can be found in the fans of automotive industry to prevent transfer the vibration from the fan to its structure, also less sound radiation and noise generation when fans operation.

Types of Elastomers

1- **Unsaturated Elastomers:** this type of elastomers can be cured by sulfur vulcanization process also can be cured by non-sulfur vulcanization if desired, for examples:

- Natural rubbers.
- Synthetic polyisoprene rubbers.
- Butadiene rubbers.
- Neoprene rubbers.
- Nitrile rubbers.
- Butyl rubbers.
- Halogenated butyl rubbers (chloro butyl rubber, bromo butyl rubber)
- Hydrogenated Nitrile rubbers.
- Styrene-butadiene rubber.

2- Saturated Elastomers: this type of elastomers cannot be cured by sulfur vulcanization process only, for examples:

- Ethylene propylene rubbers (EPR).
- Ethylene-vinyl acetate (EVA) rubbers.
- Polyacrylic rubbers.
- Silicone rubbers.
- Fluoroelastomers.
- Polyether blocks amides rubbers.
- Chlorosulfonated polyethylene rubbers.

Elastomer Adhesives

The examples of elastomers adhesives are polyurethane adhesive, adhesives based on silicones, adhesives based on modified silane. The types of elastomer adhesives include:

1- Chemically Reactive Adhesives.
2- Evaporation Adhesives (Diffusion Adhesives).
3- Hot Melt Adhesives.
4- Pressure Sensitive Adhesives.
5- Conductive Adhesives.

Important Elastomer Additives

1- Fillers.
2- Accelerators.
3- Activator.
4- Stabilizers.
5- Plasticizers.
6- Anti-degradation.
7- Flame retardants.

Classification of Elastomer Additives

A cordoning to the modification that occurs of elastomer when using the additives, the elastomer additives can be classified into five types which include:

1- Mechanical property modifier.
2- Surface property modifier.
3- Chemical property modifier.
4- Aesthetic property modifier.
5- Processing modifier.

Block Copolymers

Copolymer is one type of polymer consists of more than one types of monomer that is usually made out of two or more co-monomers. Block copolymer one type of copolymer made up by polymerization process, in which the co-monomers are separated into long sections of the polymer backbone chain and do not dissolve into one another, each of these sections called blocks. The most thermoplastic elastomer is block copolymer such as the styrene-butadiene-styrene rubber, as shown in Figure (1).

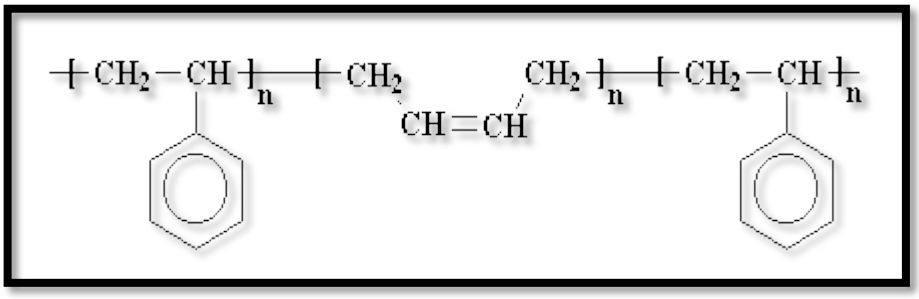

Figure (1): Structure of Poly (Styrene-Butadiene-Styrene) Block Copolymers.

The styrene-butadiene-styrene block copolymer are forming by mixing two different types of polymers that composed of butadiene repeating units in the center portion of the chain and styrene units at the ends of the chain (i.e. each polybutadiene block has a polystyrene block at each end). The styrene-butadiene-styrene (SBS) chains is made up of a short chain of polystyrene, followed by a long chain of polybutadiene, followed by another chain of polystyrene, as shows in Figure (2). This means that the different polystyrene clusters will be tied together by the polybutadiene blocks.

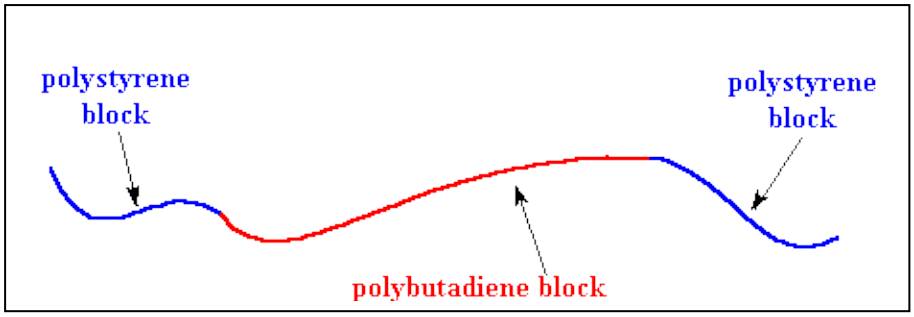

Figure (2): Molecule Chain of Poly (Styrene-Butadiene-Styrene) Block Copolymers.

The polystyrene and polybutadiene polymers are incompatible, so that the polystyrene end-groups associate together to form glassy (rigid) domains as clusters in a sea of elastic polybutadiene. The polybutadiene center portions, form elastomeric network when held together by rigid domains of polystyrene end-blocks, this is showing in Figure (3). Thus, this material is a solid at normal temperatures, which are relatively stable up to the Tg of polystyrene (100 °C).

Also the polystyrene clusters act as crosslinks for polybutadiene blocks, the polystyrene clusters break up when heated and can be separate to a parts above the Tg, because of no chemical bonds between the molecules chains, therefore these materials can be reprocess, reform and recycle.

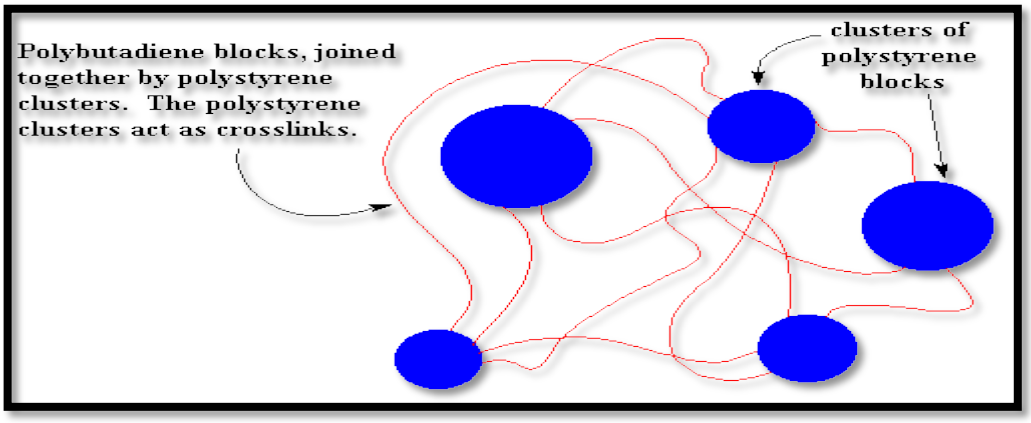

Figure (3): Elastomeric Network by Polystyrene Clusters.

Also can be prepare thermoplastic elastomer by using block copolymer made up from only one type of monomer in different tacticity by using catalysis polymerization, for example polypropylene make up from one type of monomer (propylene) is atactic blocks and other type of monomer is isotactic blocks, as

shows in Figure (4). The isotactic blocks are crystalline, but the atactic blocks are amorphous.

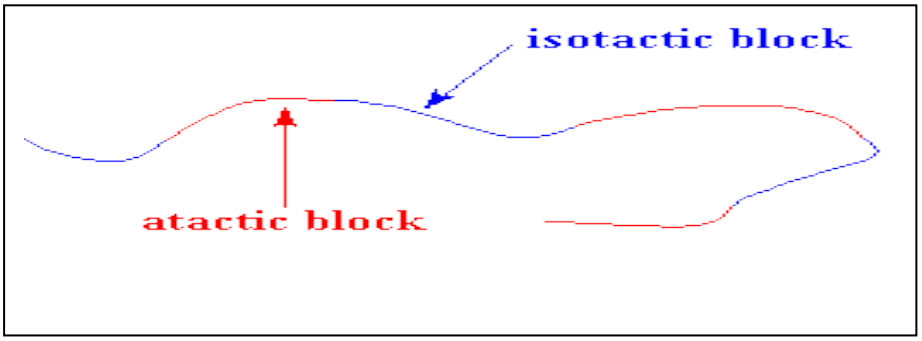

Figure (4): Molecule Chain of Polypropylene Block Copolymers.