**Introduction to polymeric engineering materials, Classification, Properties, and Applications**

Polymers are large molecules consisting of many repeating structural units. Rubber is a natural polymer . celluloid is the first plastic . The first synthetic polymer was a substance called Bakelite, which is used in stovetop appliances because of its ability to resist heat. Since the beginning of the 20th century, hundreds of polymers have been synthesized. They are easy to manufacture , starting materials used to make them are inexpensive , and they have a wide range of properties . They can be drawn into wire and be molded into shapes . children s toys are made of a polymer called polyethylene, which is made from synthesizing ethane under pressure.

Monomers are molecules from which polymers are made.Monomers bond together one after another in a rapid series of steps. Catalysts are required for the reaction to take place. With other polymers, such as nylon and Dacron, two or more kinds of monomers bond to each other in an alternating sequence. These reactions are called polymerization reactions.

There are two classes of polymers: thermoplastic and thermosetting. Thermoplastic polymers can be melted and molded repeatedly into shapes that are retained when cooled. Thermosetting polymers can be molded when first prepared, but once cool, cannot be re-melted.

polymer structure connected by covalent bond **chemistry:**

**kinetic:** produced from chemical reaction of small units,

called “monomer”

- high strength, with Tg and rubber elasticity, **property:**

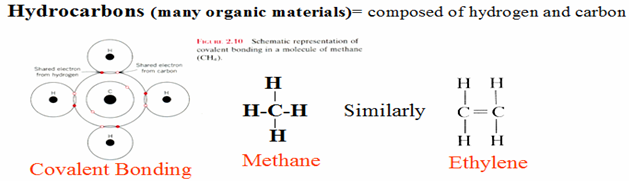
- high viscosity in melt or solution states

Natural Polymers 🡪 Leather, wood, rubber, cellulose, cotton, wool.

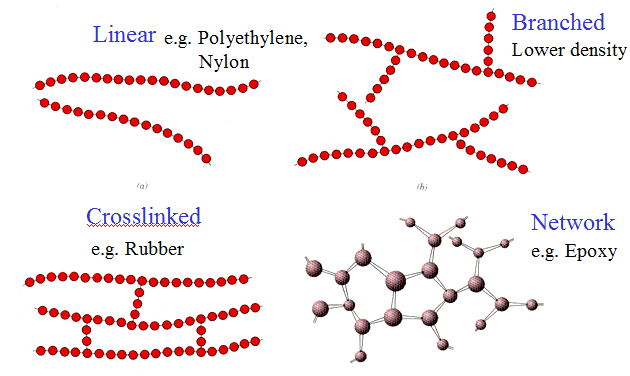
Synthetic polymers🡪 Synthesized from small organic molecules.

[Petrochemical Industry](file:///C:\Users\user\Desktop\ภาพรวมโครงสร้างอุตสาหกรรมปิโตรเคมี%20TEPE.doc) Origin of (Synthetic) Polymers(

**Chemistry of Polymer Molecules**



- **polymers are classified on the basis of their structure as below:**



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Major applications of polymers

Plastics 1.

Rubbers (or elastomers) 2.

Fibers 3.

Surface finishes and protective coatings 4.

Adhesives 5.

- some other applications

6. composites

7. Ion – exchanges resin

**1. Plastic**

6 Most Commonly-Used Recyclable Plastics



**Polyethylene Terephthalate (PET or PETE) a.**

Strength/toughness, stiffness, resistance to heat -

Transparency: Containers for water, -

Grease&Oil resistance: vegetable oil -

Gas barrier property: Container for soda, carbonated drinks -

***Uses:***-- (major) soft drink bottles, mouthwash bottles,

food blow-molded containers

-- (minor) sheet applications

-- (minor) injection molded components ex. bicycle mud guards.

-- (minor) spinning fiber for carpet yarns, fiberfill, and geotextiles.

***Recycled Products:***Tote bags, dishwashing liquid containers,

clamshells, laser toner cartridges, picnic tables, hiking boots,

mailbox posts, fencing, furniture, sweatshirts.

**High Density Polyethylene (HDPE)**  **b.**

Look milky white -

-Stiffness, strength/toughness, low cost, ease of forming

-Resistance to chemicals

Relatively straight chain structure, higher density than LDPE -

-Permeability to gas

-Ease of processing

* ***Uses:***

wide application in blow molded bottles for milk, water and fruit juices, grocery bags, toys, liquid detergent bottles.(Copolymer HDPE, pigmented with a variety of colorants, is used for packaging toiletries, detergents and similar products.)

* *Recycled Products:*

Recycling bins, benches, bird feeders, retractable pens, clipboards, fly swatters, dog houses, vitamin bottles, floor tile, liquid laundry detergent containers.

**Low Density Polyethylene (LDPE)**  **c.**

Barrier to moisture,but air can pass through -

Good electrical insulation -

- Strength/toughness, flexibility,

Ease of processing, ease of sealing, low cost -

- Low Tg can be used with frozen food

* ***Uses:***

film for plastic retail bags and grocery bags, some flexible lids, wire and cable applications Ex. Bread bags, frozen food bags, grocery bags.

* ***Recycled Products:***

Shipping envelopes, garbage can liners, floor tile, furniture, film, compost bins, paneling, trash cans, landscape timber, mud flaps.

**Polyvinyl Chloride or PVC)**  **d.**

Broadly divided into rigid and flexible materials. -

Versatility, ease of blending -

Strength/toughness -

Resistance to grease/oil and chemicals -

Clarity, Electrical Insulation -

Fire retardant -

* ***Uses***
  + Rigid PVC:60 percent of total PVC -

(pipe and fittings, siding, carpet backing, windows, bottles and packaging sheet)

* + Flexible PVC: -

(wire and cable insulation, film and sheet, floor coverings, synthetic-leather products, coatings, blood bags, medical tubing etc.)

* ***Recycled Products:***

Air bubble cushioning, flying discs, decking, film, paneling, recycling containers, roadway gutters, snowplow deflectors, playground equipment.

**2. Rubbers (or elastomers)**

Silicone rubbers

Pro:

-low and high temp stability

(-55 to 250 oC)

-elastic even at low temp.

-excellent electrical property

-extremely inert

**3. Fibers**

Cellulose plastics

- commonly found in plant’s cell wall

- Cotton consists of 90% cellulose, 10% lignin and polysaccharides

**4.Surface finishes and protective coatings**

*Paints*– need the following qualities:

-quick drying

-cling well to surfaces

-prevent erosion and corrosion

***Types of paints***

- alkyd and polyester resin

phenolic resin (reaction of phenol+formaldehyde) -

-Acrylic resin

Polyurethane -

**Adhesives**

Adhesive:is in liquid form when applying, then becomes solid and form joint between two surfaces afterwards.

**Composites 6.**

Contain at least 2 phases -

-To increase mechanical properties ex. strength, toughness, high-temp application

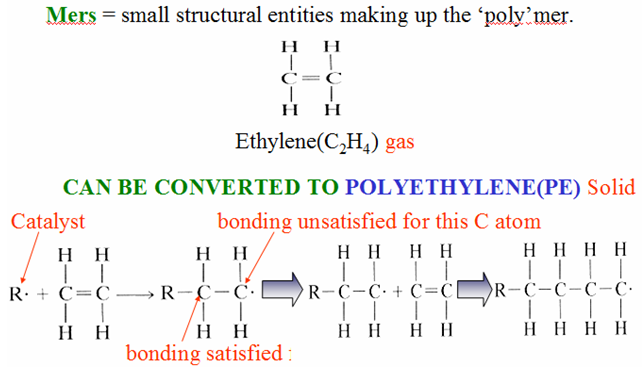
-Polymer composite: the continuous phase is polymer ------ **2 types of reinforcing materials.**

Particle reinforced composite 1.

Fiber reinforced composite 2.

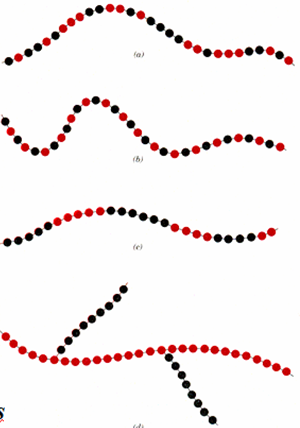
Examples of reinforcing material: glass, carbon,ceramic, Kevlar (hard polymeric polyaramid)

**polymerisation**



**Homopolymers**

**Copolymers (polymers composed of two or more different 'mer' units**



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