Ceramics

- *Ceramics are inorganic compounds of metallic and non metallic elements and their atoms are held together by ionic or covalent bond.* ***(composed of matter other than plant or animal)***
- *These bonds are stronger than metallic bond*
- *Ceramics are hard and brittle materials with high melting points*

The distinguishing characteristics of ceramics are

1. *Resistance to high temperature*
2. *Resistance to wear and corrosion*
3. *Low electrical and thermal conductivity*
4. *Low ductility*
5. *Poor conductors*

Ceramics

Applications of Ceramics

- *Clay based ceramics are used for* ***sanitary work, floor tiles and building materials***
- *Retain strength at elevated temperatures-* ***Spark plugs*** *in automobile industry*
- *High resistance to wear-* ***cylinder liners, bushings and bearings***

Ceramics

Difference between ceramics and non ceramics metals

- *Metals are good conductor of heat and electricity where as ceramics are generally poor conductors as plastics*
- *Ceramics can withstand for higher temp than metals and plastics*
- *Metals and plastics can be easily deformed in to desired shape , but not possible with ceramics*
- *Ceramics are harder than metals and plastics*

Classification of Ceramics

1. **Clay products**: Composed of silica and alumina. Ex: bricks, tiles

The most common form of crystalline silica is quartz, which is found in sand, gravel, clay, granite and many other forms of rock. Non-crystalline silica is found in glass, silicon carbide, and silicone.

2. Refractories: **Special materials capable of withstanding for high temperatures**.

A refractory material is a mineral that is resistant to decomposition by heat, pressure, or chemical attack. It most commonly refers to a mineral that retains strength and form at high temperatures.

Ex: furnace walls, crucibles and moulds

Fireclay refractories. ...

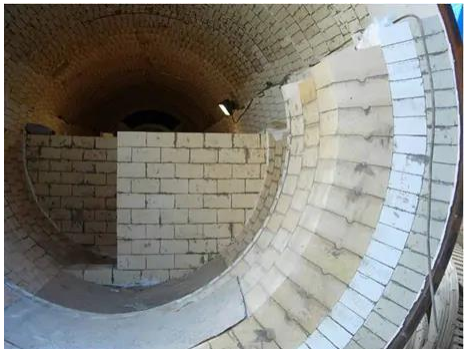
Silica brick. ...

High alumina refractories. ...

Magnesite refractories. ...

Chromite refractories. ...

Zirconia refractories.



3. Glasses: Inorganic material that has been cooled to rigid conditions without crystallization**.** Ex: Bottles, lenses, light bulbs

Glass is made from liquid sand. You can make glass by heating ordinary sand (which is mostly made of silicon dioxide) until it melts and turns into a liquid. You won't find that happening on your local beach: sand melts at the incredibly high temperature of 1700°C

Silica glasses, with additives of Na_2O, K_2O, CaO and MgO to alter the structure and reduce the melting temp. these are *Modifiers*

4. Abrasives: **Cutting tool materials Ex: SiC, CBN and grinding wheels**

Composites

Composite: *It is a material composed of two or more different materials bonded together with one serving as the continuous matrix and other as a reinforcing material.*

Types of composites: Depending on the form of reinforcing material, composite materials are classified in to

a) ***FRC (Fiber Reinforced Composite) or FRP (Fiber Reinforced Composite)***

b) ***Particulate reinforced composites (PRC)*** : Particles sizes > 1 micro meter

Note: matrix and particles bear the load

c) ***Dispersion reinforced composites***: Particles sizes < 1 micro meter

Note: Matrix take the load, particles impede the dislocations

d) ***Laminates*** *: Two layers are sandwiched or bonded together Ex. Plywood and cladding*

Composites

*Based on matrix materials, composites are classified in to **3 types***

1. ***Polymer matrix composites***
2. ***Metal matrix composites***
3. ***Ceramic matrix composites***

Applications of composites:

Aircrafts,
Automobiles
Navy
Electronic equipment and
Sporting goods

Polymers

- ***Classification of Polymers***
  - ***Classification by origin***
  - ***Classification based on structure***
  - ***Classification based on molecular forces***
  - ***Classification based on mode of polymerization***
  - ***Classification based on variety of monomers involved in the structure***

1. ***Classification of Polymers based on origin***

- ***Natural polymers*** *– These are obtained from nature,* ***e.g., plant origin, animal origin etc.*** *Biologically degradable polymers are also present, called biopolymers. Examples- Rubber, Cellulose, Protein etc. They can be divided into Polypeptides, Sugars, and Nucleic acids.*
- ***Synthetic polymers*** *– These have been prepared by humans in laboratories and are currently produced industrially.* ***Example – Plastic, PVC etc.***
- ***Semi-synthetic polymers*** *– These polymers are derived from natural sources and undergo further chemical/physical treatment before attaining their final form****. Example – Rayon, Terylene etc.***

Polymers

2. Classification of Polymers based on structure

- ***Linear Polymers*** *– Monomers join with each other to form long straight chains. Example – Poly Vinyl Chloride or PVC is a linear polymer*
- ***Branched Chain Polymers*** *– These polymers are made of branching of linear chains of monomers. They have low melting points and low densities. Example – Low-density polythene,*
- ***Cross-linked Polymers/Network Polymers*** *– These polymers are formed by bi-functional and tri-functional monomers with a strong covalent bond between the various linear polymer chains. These polymers are brittle by nature. Example – Melamine.*

Polymers

3. Classification of Polymers based on molecular forces

Thermoplastics *– These polymers become soft on the application of heat and thus can be molded in the desired shape. Example –* ***Polystyrene, polyethylene, polypropylene***

Thermosets *– These polymers have their individual chains bonded covalently during polymerization, or by application of heat or chemical treatment. Once set, their shape cannot be changed. They resist subsequent mechanical deformation or heat softening or solvent attack. Good for adhesive purposes, coatings etc****. Example – Fiberglas, melamine***

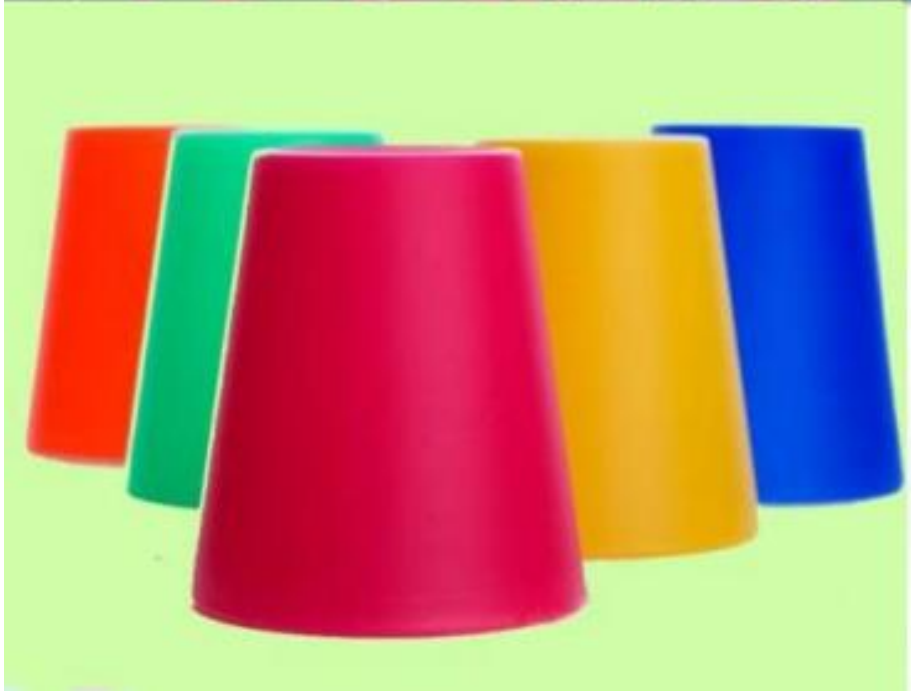
Elastomers *– Polymer chains that are elastic and can be stretched like rubber. They have weak intermolecular forces between the chains and may have cross bonds.* ***Example – Vulcanized rubber***

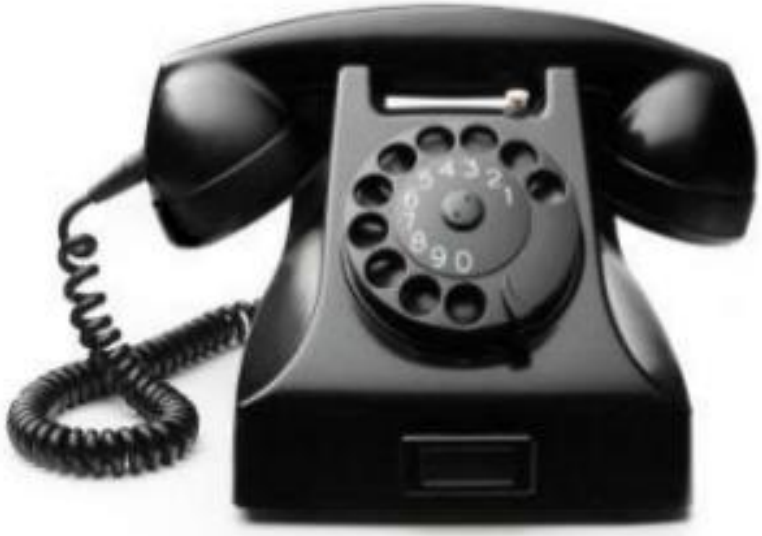
Fibers *– They have strong intermolecular forces – either hydrogen bonds or dipole-dipole interactions between their chains. These chains have a high tensile strength and less elasticity, and high melting points.* ***Example – Silk, Nylon etc.***

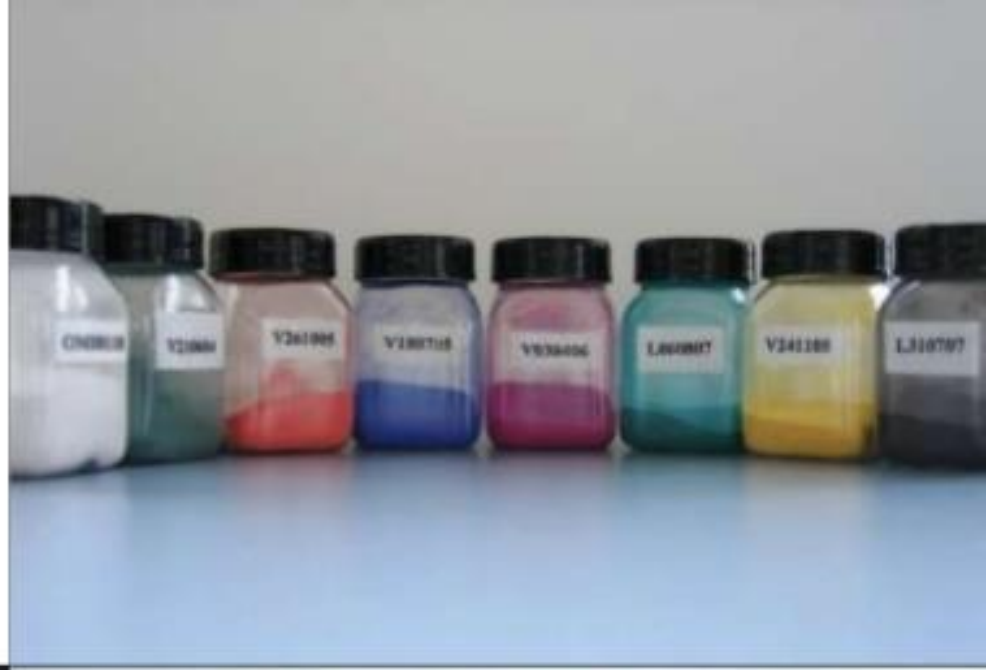
Plastics

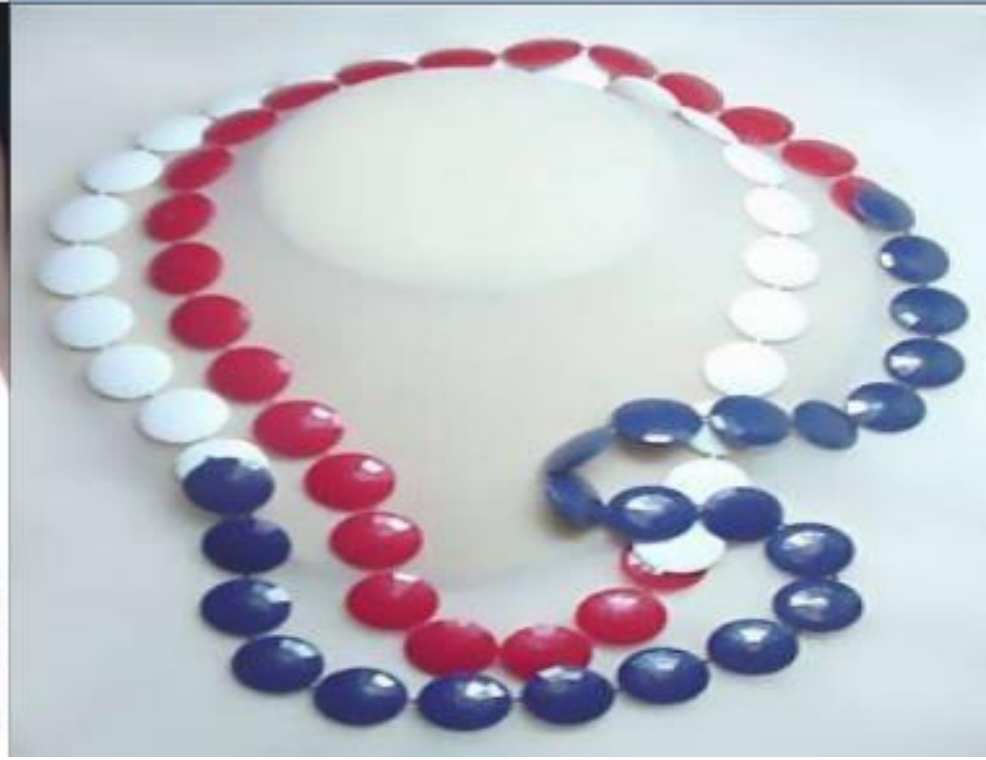
Plastic is a semi synthetic solid

- Thermo plastics and thermosets
- Polyethylene terephthalate (PET or PETE)
- High-density polyethylene (HDPE)
- Polyvinyl chloride (PVC)
- Low-density polyethylene (LDPE)
- Polypropylene (PP)
- Polystyrene (PS)



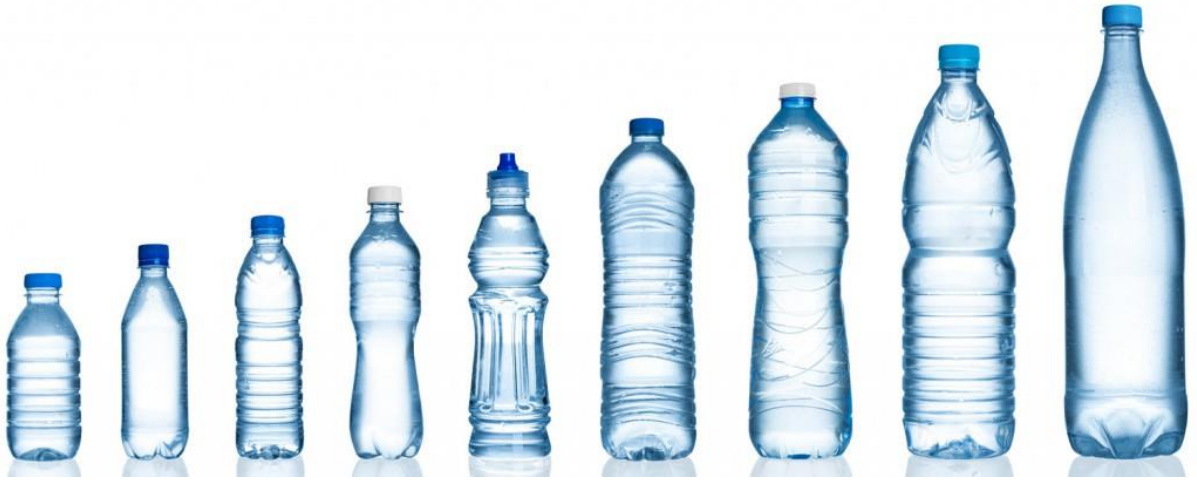






PET
Polyethylene Terephthalate

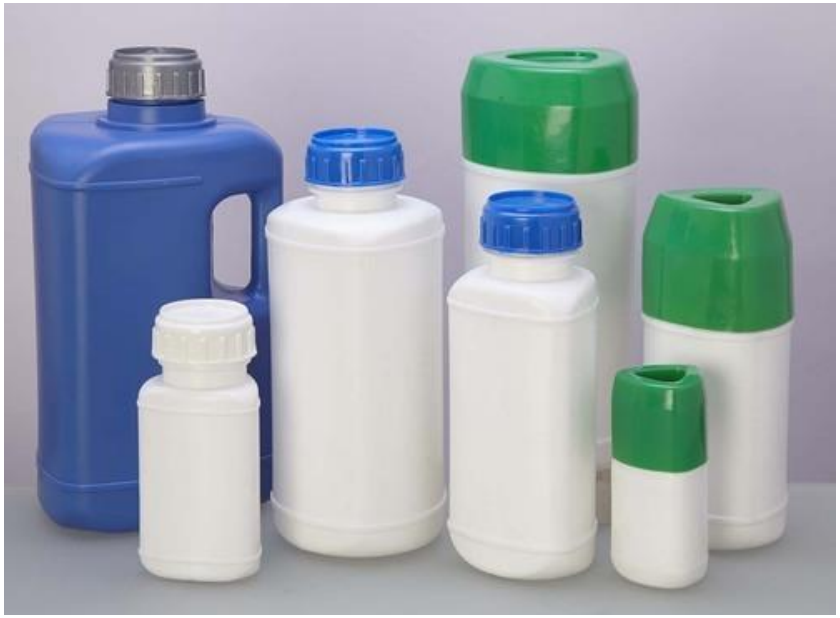
- A clear, tough, polymer with exceptional gas and moisture barrier properties.
- PET's ability to contain carbon dioxide (carbonation) make it a good choice in soft drink bottles.



HDPE (High Density Polyethylene)

- Used in milk, juice and water containers in order to take advantage of its protective barrier properties

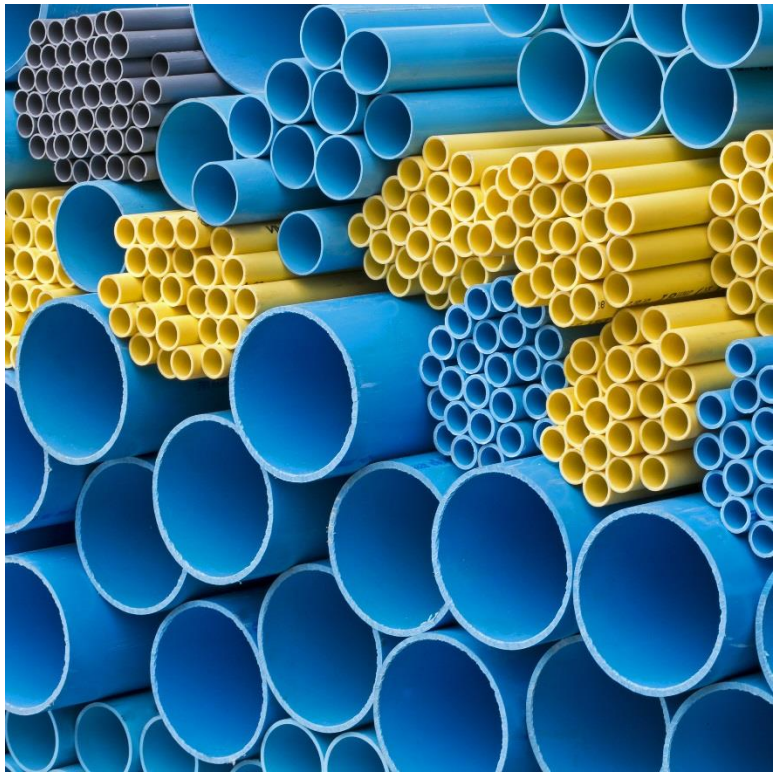
- Its chemical resistance properties make it a good choice as container for household chemicals and detergents.



Vinyl

Polyvinyl chloride, or PVC

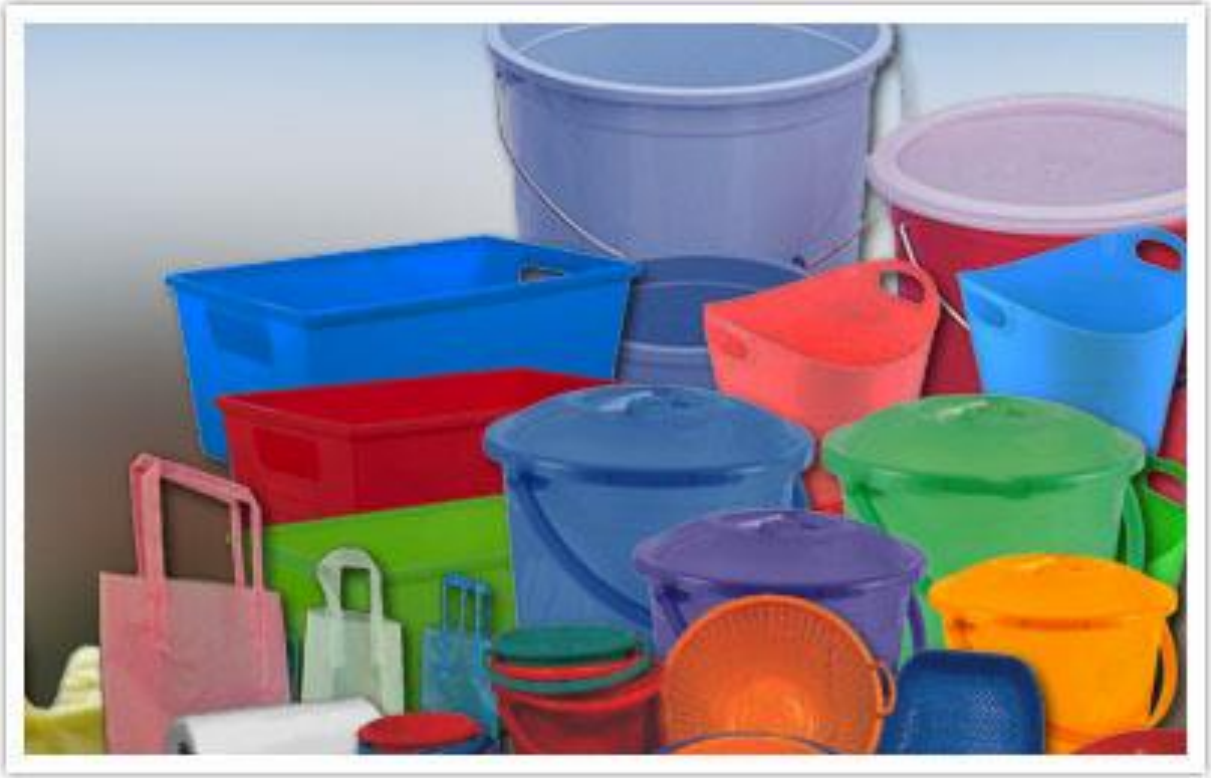
- Excellent clarity, puncture resistance and air tight
- Film vinyl can breathe, making it ideal for meats



LDPE

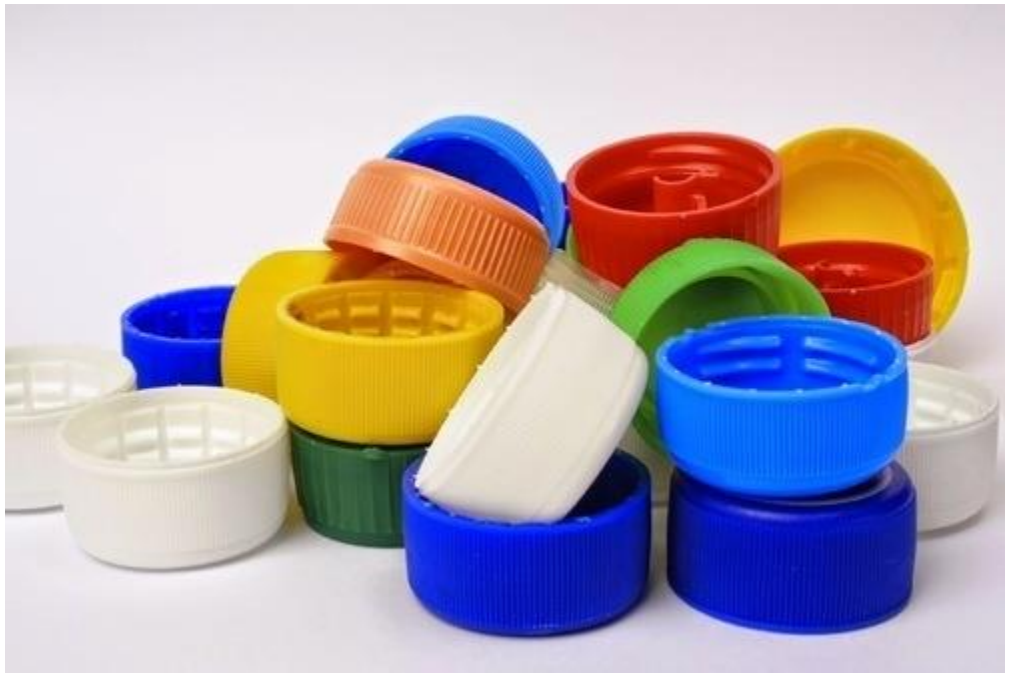
Low density polyethylene

- Makes bottles that requires flexibility
- Produces grocery bags and garbage bags, shrink and stretch film and the coating for milk cartons



PP (Polypropylene)

- High tensile strength, ideal for caps and lids with threaded openings
- High melting point so can be hot-filled with products that then will cool
- Also used for products that need to be incubated, such as yogurt

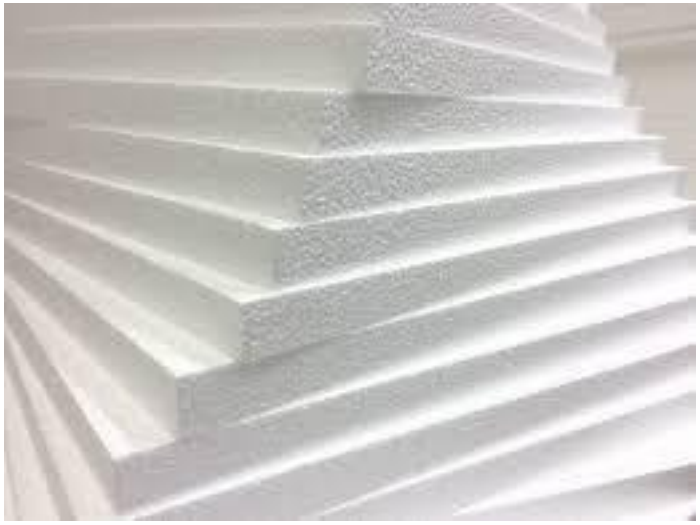


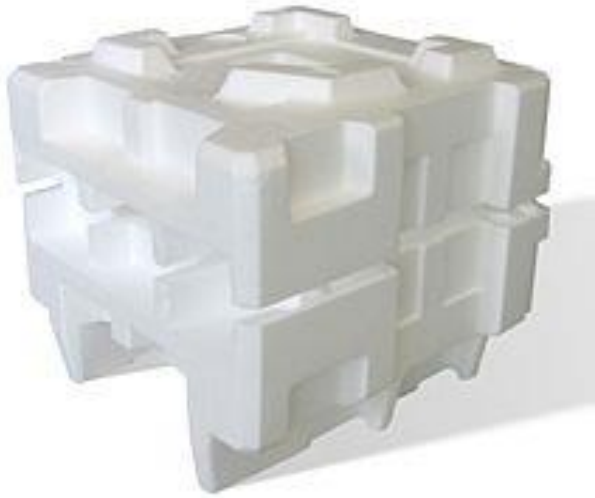
PS (Polystyrene)

- In its crystalline form, it is a colorless plastic that can be clear and hard.

- It can also be foamed to provide exceptional insulation properties. Foamed or expanded polystyrene (EPS) is used for products such as meat trays, egg cartons and coffee cups.

- It is also used for packaging and protecting appliances, electronics and other sensitive products





What kinds of products are made with recycled plastics?

- Recycled PET can be used in producing deli and bakery trays, carpets, clothing and textiles.

What kinds of products are made with recycled plastics?

Recycled HDPE can become bottles for laundry products, recycling bins, agricultural, pipe, bags, motor oil bottles, decking and pilings.

What kinds of products are made with recycled plastics?

Recycled vinyl can become playground equipment, film and air bubble cushioning.

What kinds of products are made with recycled plastics?

Recycled LDPE can be used to manufacture bags, shrink film and compost bins.

What kinds of products are made with recycled plastics?

Recycled PP can be used in automobile parts, carpets, battery casings, textiles, industrial fibers and films used for packaging products such as candy.

What kinds of products are made with recycled plastics?

Recycled PS can be used in products including office accessories, video cassettes and cases.

Semiconductors

Semiconductors are two types 1. Intrinsic and 2. Extrinsic

A perfect semiconductor crystal containing no impurities or lattice defects is called an intrinsic semiconductor. As the carriers are generated in pairs, the concentration n of electrons in the conduction band equals the concentration p of holes in the valence band,

Extrinsic semiconductors:

we can add impurities to make a material semiconducting (or to change the properties of the gap).

There are 2 types of extrinsic semiconductors:

p-type and n-type

These are materials which have mostly hole carriers (p) or electron carriers (n).

These give you ways of modifying the band gap energies (important for electronics, detectors, etc).