

# Materials and their properties– Plastics (Polymers)

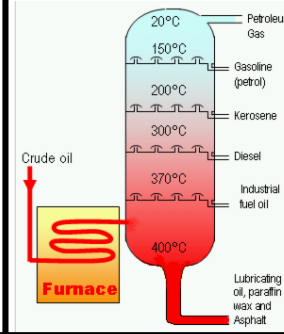
## What you need to know:

- Know the primary sources of materials for producing polymers
- Be able to recognise and characterise different types of polymers
- Understand the physical working properties for a range of thermosetting and thermoplastics.

Man made (synthetic) plastics have replaced wood and metal in the manufacture of a wide range of products. The 1<sup>st</sup> synthetic plastic was celluloid. It was made from cotton and camphor and used for table tennis balls and film.

Commercial production of plastics really started after the 2nd World War. The raw materials used were either coal or oil. They contain a number of different chemicals which can be separated into parts by a process called **Fractional Distillation**.

Some of the fractions contain chemicals that are small molecules (**Monomers**). The monomers are chemically joined together to make longer molecular 'chains' called



### Polymers

**Plasticisers** are added to make plastic bendy.



**Pigments** are added to change colour.



**Antistatics** are used to reduce static charge



**Antioxidants** to reduce attack by air



**Flame retardants** to reduce burning



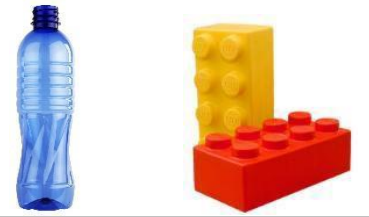
### Problems of using plastics

Plastic products have a long shelf life, however it also means that they are difficult to dispose of

- Because they do not rot or corrode they are difficult to dispose of
- If burnt they produce black choking gasses
- When molten they are sticky and can cause severe burns
- Thermoplastics can be recycled by melting them down and reforming their shape, but usefulness can be limited with frequent heating
- Plastic production itself can be polluting
- PVC contains many nasty pollutants and it is one of the most difficult plastics to recycle.

There are many different types of plastic and can be split into four groups :

**THERMOPLASTICS** are made from long chain polymers, joined by weak chemical bonds. When the plastic is softened by heat the bonds break making the plastic 'semi fluid' and able to be shaped. As the plastic cools, new weak bonds form and the shape will be fixed. Because no chemical reaction has taken place this process can be repeated many times, making them recyclable, however excessive heat will permanently damage the chemical structure.



**THERMOSETS** or thermosetting plastics are plastics which are converted into their final form by heat. Once set, they cannot be softened by further heating as they undergo a chemical change. They have strong chemical bonds that hold the long chains together. These make thermosets heat resistant but not recyclable. It is difficult to make products by extrusion or injection moulding as they harden as soon as heated. Manufacturing methods include casting, moulding and laminating.



**ELASTOMERS** are a type of thermoset. The bonds between the chains are 'springy' giving them a rubbery quality. Natural rubber is an example it can be vulcanised to make a rigid (ebonite). Latex is a stretchy elastomer used to make surgical gloves. Lycra is an elastomer used to make stretchy clothing.



Ebonite is an early form of plastic that was used to simulate ebony and is hard and used for bowling balls

**COMPOSITES** are when materials are combined to achieve specific advantages. Examples of composites are Kevlar, GRP (Glass reinforced plastic), Graphite and Carbon Fibre. These are used extensively for sporting uses e.g Bike parts, motor racing car bodies and tennis rackets.



## Thermoplastics

**Acrylonitrile Butadiene Styrene (ABS)** is strong, tough, scratch resistant and resists heat and chemicals. It is injection moulded to make Lego bricks and is used extensively for household appliances like Kettles, vacuum cleaners and housings for cameras and telephones.



**High Density Polythene (HDPE)** is tough and can be blow moulded (bottles for bleach and shampoo) injection moulded (toys and buckets) and extruded (piping)



**Polystyrene (PS)** is used to make vending cups and model kits. It is light, transparent but quite brittle. It is vulcanised to make **High Impact Polystyrene (HIPS)** This is used for Vacuum forming in thin sheets, which are cheap and easy to work with. **Expanded Polystyrene (EPS)** is used as thermal insulation for packaging and food cartons. It is 90% air.



**Low Density Polythene (LDPE)** is Made into thin film (Carrier bags, wiring insulation and squeeze bottles)



## Thermosetting plastics



**Polyester Resins** which are combined with fibreglass to produce GRP



**Phenol Formaldehyde** is tough and heat resistant often black in colour. (Used for saucepan handles)



**Epoxy Resins** which are mixed with a hardener and left to set. They can be used to make adhesives and flooring.

