Rewarding Learning

AS LEVEL Section A

FACT FILES

Technology & Design

For first teaching from September 2011

For first award in Summer 2012

Plastic

tech nology and design

FACT FILE

1.4 Plastic

Learning Outcomes

Students should be able to:

- Understand the difference between thermoplastic and thermomsetting plastics;
- Demonstrate knowledge and understanding of the properties, working characteristics and uses for the following polymers – polythene, polystyrene, PVC, acrylic, nylon, ABS, melamine-formaldehyde and epoxy resins.

Course Content

There are 2 main types of plastics:

1. Thermoplastics
2. Thermosetting plastics

Thermoplastics

These plastics can be re-heated and therefore shaped in various ways. They become mouldable after reheating as they do not undergo significant chemical or molecular change. Reheating and shaping can be repeated. The bond between the molecules is weak and become weaker when reheated, allowing reshaping. Thermoplastics tend to be composed of 'long chain monomers'. These types of plastics can be recycled.

These plastics can be easily moulded and are economically viable for industrial use due to the fact that that can be re-used. However, with the exception of PTFE, the weakness of Thermoplastics is that when heat is applied to them they are less useful. At temperatures of over 100°C they tend to lose their rigidity and soften due to the bond between the molecules being weak and becoming weaker when reheated, allowing reshaping.

Thermoplastic articles are formed at relatively high temperatures and are cooled to set in a desired shape. They can be reheated and reshaped many times without changing their structure and properties.
Common examples of thermoplastics are:

- Polythene (bottles, pipes, packaging etc.)
- Nylon (fabrics, gear wheels, bearings etc.)
- PVC (cable insulation, guttering, window frames etc.)
- Polystyrene (flower pots, model kits, packaging etc.)
- Acrylic
- ABS (kitchen ware, safety helmets, car components etc.)

Material	Forms	Properties	Uses
(LDPE) Polythene (HDPE)	Powder, granules, sheet Powder, film, sheet	**Low density:** Tough, good chemical resistance, flexible, soft, electrical insulator, available in a range of colours. **High density:** stiff, harder than LDPE, high softening point, waxy texture, can be sterilised.	Kitchen ware, buckets, food bags, bottles. Food containers, lamp shades, yoghurt cartons.
Polyamide (Nylon)	Powder, granules, rod, tube, sheet.	Hard, clear, very durable, tough, resilient to wear, low coefficient of friction and self-lubricating, resistant to high temperature, machines well, difficult to join.	Gears, bearings, washers, bristles, textiles, clothing, stocking etc.
Polyvinyl chloride (PVC)	Rigid - Powder, pastes. Flexible – powders, pastes, liquid, sheet	Weather resistant, stiff, hard, tough, lightweight, range of colours, needs to be stabilised for outdoor use. Soft, flexible, good electrical insulator.	Pipes, guttering, bottles, shoe soles, window frames, hosepipes.
Polystyrene (PS) (HIPS)	Powders, granules, sheet, expanded foam, beads, slabs.	**Conventional:** Light, hard, stiff, colourless, transparent, brittle, low impact strength, hygienic with food, water resistant **Toughened:** increased impact strength, pigmented. **Expanded/foam:** buoyant, lightweight, crumbles, good sound and heat insulator.	Model kits, packaging, disposable plates/cups. Refrigerator linings, toys. Sound and heat insulation, packaging.
Polymethyl methacrylate (Acrylic)	Sheet, rod, tube.	Stiff, hard, durable, similar impact resistance as glass, scratches easily, fibre optic qualities, hygienic with food, good electrical insulator, colours, polishes and machines well.	Illuminated signs, windows, rear car lights, reflectors, sanitary ware, light units.
Acrylonitrile butadienestyrene (ABS)	Powder, granules	High impact strength, tough, scratch resistant, lightweight, durable, high quality surface finish, resistant to chemicals.	Safety helmets, car components, kitchen ware, durable cases for electronic products, toys.

Examples of products manufactured using thermoplastics:

Polythene

Nylon

PVC

Polystyrene

Acrylic

ABS

Thermosetting plastics

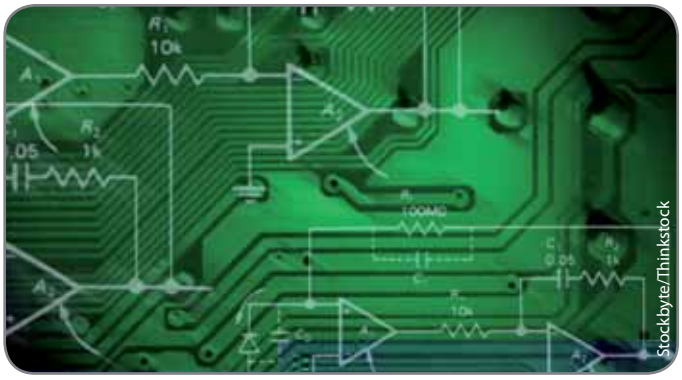
Once 'set' these plastics cannot be reheated to soften, shape and mould. The molecules of these plastics are cross linked in three dimensions and this is why they cannot be reshaped or recycled. The bond between the molecules is very strong These plastics can withstand heat much better than Thermoplastics without losing their rigidity and they are good insulators.

Common examples of thermosetting plastics include:

- Melamine formaldehyde
- Epoxy resin

Material	Forms	Properties	Uses
Melamine formaldehyde	Laminates, granules, powders.	Hard, resists scratches and marking, strong, brittle, odourless, stain resistant, resists some chemicals, wide range of colours, tasteless.	Tableware, buttons, laminated work surfaces, electrical insulation, cookers, refrigerators.
Epoxy resin	Liquids, pastes.	High strength when reinforced, high adhesive qualities (low shrinkage), good chemical and wear resistance, heat resistant to 250°C.	Surface coatings, bonding agent, encapsulation, laminating, PCB.

Examples of products manufactured using thermosetting plastics:



Epoxy resin

Melamine formaldehyde

Revision questions

1. Briefly explain the difference between thermoplastic and thermosetting plastics.

2. For each application listed below, select a suitable plastic from acrylic, nylon and polystyrene, and give **one** main reason for your choice.
   a. Shop signs.
   b. Beads for wall insulation.
   c. Gearwheels.
   d. Packaging.

3. Give **one** main reason why:
   a. Acrylic is used for illuminated signs.
   b. Nylon is used for gear wheels.
   c. Polyvinyl chloride (PVC) is used for drain pipes and guttering.
   d. Polythene is used for detergent bottles.

4. ABS and polystyrene are used in a range of products.
   a. Give **two** main characteristics of ABS which make it suitable for certain parts of children's toys.
   b. Give **two** main characteristics of polystyrene which it suitable for cups in vending machines or yoghurts pots.

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