FACTFILE:
GCSE
Technology and Design

Rewarding Learning

UNIT: 1.2 – MATERIALS AND THEIR GENERAL PHYSICAL, AESTHETIC AND STRUCTURAL CHARACTERISTICS

Thermosetting Plastics

Learning Outcomes

You should be able to:

- demonstrate understanding of the main properties and applications of the following plastics:
  - thermosetting plastics (melamine, polyester resin, epoxy resin and urea formaldehyde).

Course Content

Plastics can be divided into two groups:

1. Thermoplastics
2. Thermosetting plastics

Thermosetting plastics

Thermosetting plastics can only be heated and shaped once. Once thermosetting plastics are formed, they set and the molecules become interlinked in a way which does not allow them be re-heated, re-shaped or recycled (unlike thermoplastics).

Thermosetting plastics are less common than thermoplastics but they often have better mechanical properties and can resist higher temperatures making them ideal for products such as saucepan handles, electrical fittings etc. Thermosetting plastics are usually available as granules, powders, liquids and pastes but are not used for school projects as much as thermoplastics owing to the nature of the processing required.

Figure 1

Melamine

Melamine is a very hard, durable and heat resistant plastic making it very popular in kitchens and tableware. Figure 1 shows a kitchen worktop which consists of a manmade board that has been laminated with melamine. Very often kitchen cupboards and office desks are made in the same way. Melamine has the added benefit of being food hygienic, easy to clean and can be produced with a variety of aesthetic finishes e.g. wood grain effect. Care must be taken however when installing melamine laminated products as they can be easily chipped along the edges.

Melamine can also be produced as flame retardant fibre making it very important in products such as welding gloves or where there are potential fire risks, e.g. mattresses.

Figure 2

Polyester resin

Polyester resin is a strong, stiff and tough thermosetting plastic. The marine industry as we know it owes much of its development to reinforced plastics which use polyester resin. This type of thermoplastic is widely used in building all sorts of boats from yachts to canoes. The kayak shown in Figure 2 uses a glass fibre matrix embedded into polyester resin to create a composite for the main body. Polyester resin has very good resistance to water absorption and is obviously light in weight compared with more traditional boat building materials such as wood and metals. Despite its value, polyester resin is losing favour to epoxy resin which has superior properties.

Figure 3

Epoxy Resin

Epoxy resin is used in a similar way to polyester resin but given its greater level of toughness and strength it has become the more established resin for coatings and binding composites. Epoxy resin has excellent adhesive properties and can be used solely as an adhesive as shown in Figure 3. Although it is more expensive than polyester resin, epoxy is more resistant to moisture and fatigue making it more durable and longer lasting. With this is mind, it is easy to see why it is used in the aerospace industry as well as in paints and protective coatings in electronics.

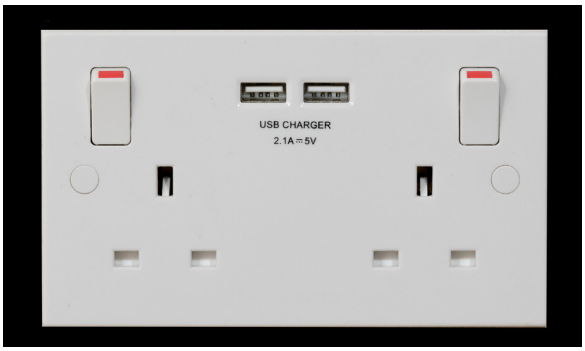

Figure 4

Urea Formaldehyde

Urea formaldehyde is commonly produced as a stiff non-transparent plastic. It is very hard, has excellent tensile strength and is an excellent insulator making it ideal for electrical sockets similar to the one shown in Figure 4.

Urea formaldehyde is also available as a low cost resin used in adhesives and as a binding agent for plywood and in particular MDF (Medium Density Fibreboard).

It is important to be aware of the application of thermosetting plastics in commercial product design as well as their properties as outlined in the table below.

Thermosetting Plastics	Properties	Application
Melamine	Strong, hard, stiff and reasonably tough Food hygienic Excellent electrical insulator Good chemical resistance Excellent flame resistance Can be produced in rigid form or as a fibre	Laminates for kitchen worktops, office desks and flooring. Melamine tableware, ashtrays etc. Personal Protective Equipment (PPE), e.g. for Fire-fighters. Mattresses
Polyester Resin	Strong, hard, stiff and fairly tough Good adhesive properties Good electrical insulator Good chemical resistance Good resistance to water absorption	Boats, canoes, kayaks. Car bodies Patio furniture Suitcases
Epoxy Resin	Strong, hard, stiff and very tough Excellent adhesive properties Excellent electrical insulator Good chemical resistance Excellent resistance to water absorption Better mechanical properties than polyester resin (but very expensive)	Adhesives (industrial) Paints/surface coatings Encapsulating/coating electronic components, PCB's
Urea Formaldehyde	Strong (tensile) hard, stiff and fairly tough Good adhesive properties Excellent electrical insulator Good chemical resistance Good resistance to water absorption	Electrical fittings Door handles Cooker knobs Adhesives MDF resin

Student Task

Identify **two** products found in the home, garden or garage which are made from or use thermosetting resins or parts.

Carry out some research into which type of thermosetting plastic has been used and explain how each product has benefitted by discussing **three** key material properties. The link shown below may act as a starting point:

https://www.youtube.com/watch?v=zPkhdQL2Eos

Revision questions

1. Explain the difference between a thermoplastic and a thermosetting plastic in relation to heating and shaping.

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2. Give **one** advantage and **one** disadvantage of a thermosetting plastic.

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3. Suggest a suitable thermoplastic for each of the following:

   a. Heat resistant gloves.

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   b. Garden furniture.

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   c. Wall socket.

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   d. Coating for a transistor.

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4. Give **two** reasons why epoxy resin is better for repairing boats than polyester resin.

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