

AS LEVEL Section D

FACT FILES

Technology & Design

For first teaching from September 2011

For first award in Summer 2012

Materials Part 3



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Learning Outcomes

At the end of this unit students should be able to:

- Demonstrate knowledge, understanding and applications for the following compliant materials:
 - Carbon fibre reinforced plastic (CFRP);
 - Glass reinforced plastic (GRP);
 - Kevlar and;
 - Tungsten carbide.



Course Content

What are Natural Rubbers?

Natural rubber is an elastic material obtained from the latex sap of trees. An incision would be made into the bark of the tree and the latex sap collected and refined into an appropriate rubber.



Rubbers are polymeric materials endowed with the properties of flexibility and extensibility. When a force is applied the molecules straighten out in the direction they are being pulled; on release from being extended, they recover their normal, random arrangements.

Advantages of Natural Rubber

- Excellent abrasive resistance and tensile strength
- Excellent elasticity, resilience, and toughness
- Low heat build-up
- Excellent impact strength
- Excellent water resistance.



Disadvantages of Natural Rubber

- Latex contains proteins that can cause severe allergic response
- Poor resistance to chemicals.

Natural Rubber Applications

Because of the advantages outlined above natural rubber (NR) is the basic constituent of many products used in the industrial, consumer, transportation and medical sectors.

Of all these major end-users for rubber, transportation is by far the largest single sector, with tyres and tyre products accounting for over 50% of NR consumption. Lorries and bus tyres represent the largest single outlet for NR, followed by car tyres.



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Other rubber goods for commercial and industrial use account for the remaining 50%. Components from the industrial sector include belts, hoses, tubes and industrial lining. Examples of rubber goods from the consumer sector include gloves, erasers, rubber bands golf balls and a range of sport footwear.

What are Thermoplastic Elastomers?

Thermoplastic Elastomers (TPE) are a physical mix of polymers (usually a plastic and a rubber) which consist of materials with both thermoplastic and elastomeric properties. They can be repeatedly stretched without permanently deforming the shape of the component. Unlike rubber-like elastomers, they do not require curing as they are true thermoplastics.



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Thermoplastic elastomer (TPE) materials combine the functional performance and properties of thermoset rubbers with the processability of thermoplastics. TPEs permit manufacturer of "rubber-like" products with the speed, efficiency, and economy of injection moulding, extrusion and blow moulding. As a result Thermoplastic elastomers have replaced rubber in many applications, most notably the automotive industry.

Advantages of Thermoplastic Elastomers

- Good Adhesion and flexibility;
- Good Weather and Chemical Resistance;
- Good Processability;
- Recyclable Material.



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Disadvantages of Thermoplastic Elastomers

- Relatively high cost;
- Durability and toughness lower than other elastomers



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Thermoplastic Elastomers Applications

TPEs are used where some elastomers cannot provide the range of physical properties needed in the product. These materials are largely used in the automotive sector in particular the interior parts of cars and in household appliances. Other consumer products examples include, sporting, medical and healthcare products.



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What are Thermoplastic Polyurethanes?

Thermoplastic Polyurethanes are high-tech materials with a unique combination of very useful properties. This unique combination is based primarily on polyesters, polyethers, copolymers, and blends of polyurethane and polycarbonates.

Thermoplastic Polyurethane (TPU) has been in use as a fabric coating material in the textile industry for many years. Thermoplastic Polyurethane's first application was as a replacement for PVC. This was mainly due to the fact that PVC was not flexible enough.



As a result Thermoplastic Polyurethane is now employed successfully across a number of sectors within the economy, including the sport, recreation and the automotive industries.

Advantages of Thermoplastic Polyurethane

The main advantages of using Thermoplastic Polyurethane are:

- excellent abrasion resistance, impact strength;
- outstanding toughness and flexibility;
- has a rubber-like elasticity;
- good resistance against oil, grease, abrasion and attack of fungi.



Disadvantages of Thermoplastic Polyurethane

The main disadvantages of using Thermoplastic Polyurethane are:

- some grades have a short shelf life;
- drying is required before processing.

Applications of Thermoplastic Polyurethane

Thermoplastic Polyurethane has a wide range of properties which makes it suitable for the following products for the following:

- car bumpers;
- bearings;
- gaskets;
- belts;
- containers;
- protective coverings for phones;
- computer components;
- floatation devices;
- glass frames; and
- handbags.



Revision questions

1. Briefly outline **two** main characteristics associated with natural rubber and give **two** specific applications for its use.
2. Briefly outline **two** advantages and **two** disadvantages of using thermoplastic elastomers.
3. Explain **two** main characteristics associated with Thermoplastic Polyurethanes.