

AS LEVEL Section D

FACT FILES

Technology & Design

For first teaching from September 2011

For first award in Summer 2012

Materials Part 2



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design



Learning Outcomes

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

Demonstrate knowledge, understanding and applications for the following composites:

- Carbon fibre reinforced plastic (CFRP);
- Glass reinforced plastic (GRP);
- Kevlar and;
- Tungsten carbide.



Course Content

What are Carbon fibre reinforced plastics?

Carbon fibre-reinforced polymer (CFRP or CRP), is a very strong, light, and expensive composite material or fibre-reinforced polymer.

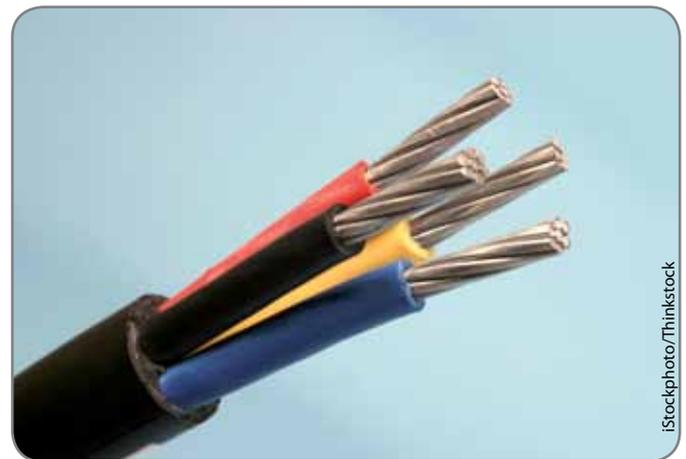
Due to its property of high strength to weight ratio it is widely used in motorcycles, bicycles, sailboats and the aerospace and car industries. In addition the improvements made in manufacturing techniques have reduced costs and time to manufacture. As a result CFRP is widely used in products such as laptops, fishing rods, paintball and archery equipment, tennis and squash racquets, golf clubs, and pool and snooker cues.



Advantages of CFRP

The advantages of the use of CFRP as a structural material are;

- Strong: high strength to weight ratio.
- Light weight: only two-thirds the weight of aluminum and 20% of steel.
- Durable - resistant to chemical corrosion.
- Excellent thermal and electrical insulating properties.
- Low to maintain as painting is not required.



CFRP Applications

The examples below demonstrate the diverse range of applications for carbon fibre-reinforced plastic given its properties.

1. A carbon fibre canoe



2. Carbon fibre-reinforced plastic (CFRP) is widely used in competitive sports equipment for example in racing bicycles. A carbon-fibre racing frame weighs less than a bicycle made from tubing of aluminum or steel offering the same strength. The use of carbon fibre has extended to different components of the bicycle for example the forks on racing bicycles are now produced using CFRP.



What are Glass reinforced plastics?

Glass-reinforced plastic (GRP), has a plastic matrix reinforced by fine fibres made of glass. GRP is a lightweight, strong material with many uses, it is used in boats, cars, water tanks, roofing, pipes, cladding and external door skins. It is more commonly known as fibreglass.



3. Shoe manufacturers use carbon fibre as a shank plate in their basketball trainers to keep the foot stable. It usually runs the length of the trainer just above the sole and is left exposed in some areas, usually in the arch of the foot.



Advantages of Glass reinforced plastic

These are some of the advantages of Glass-reinforced plastic:

- GRP is a lightweight and a strong material.
- The stiffness and strength properties of GRP can be controlled when multiple layers of fibre are oriented in various directions.
- A weather resistant finish can be produced, with a variety of surface textures and an unlimited colour range is available.



4. The fire resistance of plastic composites is significantly improved if carbon fibres are moulded into the product near the surface as carbon fibres reflects heat very well.

Applications of Glass reinforced plastic

GRP uses include hot tubs, pipes for drinking water and sewers, office plant display containers and flat roof systems. The use of GPR has been aided by advancements in manufacturing techniques and the very good tensile strength possible with fiber-reinforced plastics. Storage tanks, septic tanks and chemical tanks can be made of GRP with a large storage capacity.



House building

GRP is used in the house building market as it is lighter than conventional materials and makes for a faster installation. As a result glass reinforced plastics are used for; door surrounds, over-door and window canopies, dormers, chimneys, coping systems and keystones and sills.

Piping

GRP can be used for a variety of applications, above and under the ground. The following examples show some of its applications;

- Firewater systems;
- Pipes for drinking water;
- Waste water and Sewage systems.



What exactly is Kevlar?

Kevlar is a modern super-strong plastic. It has amazing properties which are partly due to its chemical structure (how the atoms in its molecules are arranged) and partly due to the way it is manufactured into fibres that are knitted very tightly together.



Photo: Super-strong Kevlar is best known for its use in body armour.

Advantages of Kevlar

These are some of the advantages of Kevlar:

- It is strong but relatively light (the specific tensile strength of both Kevlar 29 and Kevlar 49 is over eight times greater than that of steel wire).
- It is reasonably good at withstanding temperatures and decomposes only at about 450°C (850°F).
- Very low temperatures have no effect on Kevlar.
- Kevlar can resist attacks from many different chemicals.

Applications of Kevlar

Kevlar can be used by itself or as part of a composite material it is used in many products. Kevlar is well known for its use in bulletproof vests and knife proof body armour, but it has many other applications as well. It is used as reinforcement in car tyres, in car brakes, for boatbuilding, in the strings of archery bows, aircraft bodies and even as a durable building material.



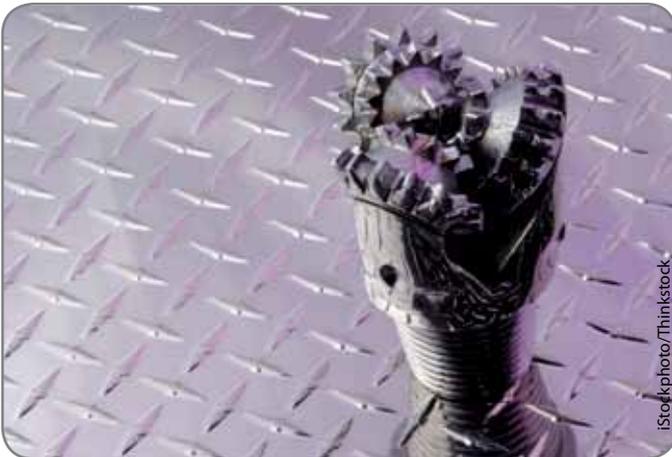
What is Tungsten Carbide?

Tungsten Carbide (WC) is an inorganic chemical compound containing equal parts of tungsten and carbon atoms. In its most basic form, it is a fine gray powder, but it can be pressed and formed into shapes for use in industrial machinery, tools, abrasives, as well as jewellery.



Advantages of Tungsten Carbide

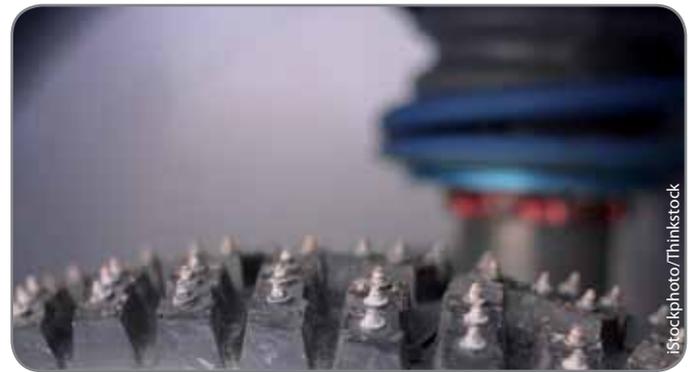
- Tungsten carbide has a very high strength for a material so hard and rigid.
- Impact resistance is high.
- Very good thermal and electrical conductivity.
- Good anti corrosive resistance.
- Very good wearing characteristics.
- Tungsten carbide is a very stable material.



Applications of Tungsten Carbide?

Tungsten carbide has a wide range of applications in the drilling, mining and construction industries. In drilling, carbide cutting surfaces are often used for machining through materials such as carbon steel or stainless steel, as well as in situations where other tools would wear away quickly. Carbide produces a very good quality finish on a part, and enables it to be machined quickly. Carbide tools can also withstand higher temperatures than standard high speed steel tools.

Other examples include tyre manufacturers with tungsten carbide studs for better traction on ice. These are generally preferred to steel studs because of their superior resistance to wear.



A tyre with tungsten carbide spikes. The spikes are surrounded in aluminum. In the smaller consumer product range, Tungsten carbide is used in trekking poles for hikers, for rings and necklaces, in the rotating ball in the tips of ballpoint pens, filaments in light bulbs and in televisions and cell phones.



Revision questions

1. Briefly outline **two** main characteristics associated with Carbon fibre reinforced plastic (CFRP).
2. Distinguish between CFRP and GRP. Briefly outline **two** specific applications for each.
3. Briefly outline **two** main properties of Tungsten Carbide which makes it suitable for cutting tools.