Composites and Smart Materials

Knowledge Organiser

WJEC ENGINEERING

A smart material reacts to external changes such as temperature, voltage or light. It will change its own colour or shape etc… as the reaction

Thermochromic Materials

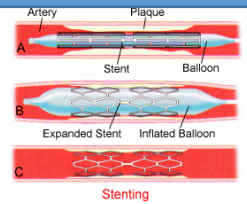
React to heat

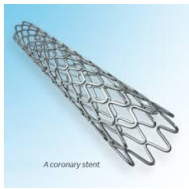
Polymorph Low Melt Plastic

D30 Shock Absorbing Polymer

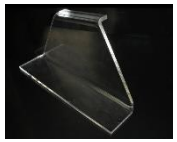
Shape Memory Alloy (SMA)

Nitinol = nickel +titanium





Acrylic has 'plastic memory'.



Photochromic Materials

React to light

Input ⟶ Process ⟶ Output

Inputs

- Heat
- Electricity (voltage)
- Pressure
- Light

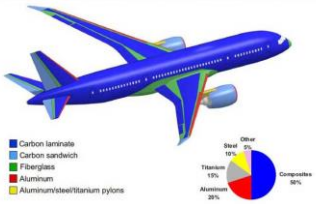
Outputs

- Change of shape
- Change of colour
- Change of conductivity

Carbon Fibre

Carbon fibre is a newer and much better but more expensive version of GRP. Carbon fibres are used instead of glass fibres.

CFRP (carbon fibre reinforced polymer) can be around four times **stiffer** and fifteen times stronger than steel



Kevlar (Aramid)

BULLET / STAB PROOF VESTS

BICYCLE TYRES

Kevlar - polymer fibre used for bulletproof clothing and puncture resistance. V**ery high tensile strength to weight ratio.** The tightly woven mat spreads the force of a sharp object and prevents it puncturing

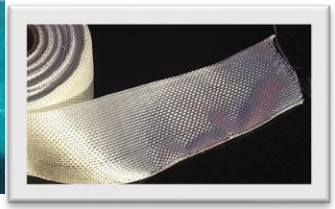
A composite is two or more materials bonded together to produce a new material with specific –improved- properties.

GRP

GRP is also known as fibreglass. Fine strands (fibres) of glass are embedded in a polyester resin to reinforce it and improve strength

GRP hand lay-up materials

Woven glass fibre tape



Thermochromic Pigments (Inks)
What might be the input on a can of drink which changes colour in a smart way?

Describe how a thermochromic ink strip thermometer works (3)

A modern bicycle frame is made of a composite material. Name this material (1)

State two advantages and two disadvantages, to the manufacturer, of using this rather than steel or aluminium (4)

GRP
What is GRP also know as?
Why would GRP not be stiff if there were no fibres embedded in the polyester resin? (2)

Why are boat hulls made of GRP (3)

Shape Memory Alloys
Is Nitinol a shape memory alloy?
Why does a nitinol stent expand when it is put in the body? (2)

What two metals are in nitinol?

What does SMA stand for?

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Carbon Fibre
Which is cheaper glass fibre or carbon fibre?
Name three products made using carbon fibre (3)

Why is carbon fibre used in road bike frames? (3)

Photochromic Glass
Name two products that use photochromic glass (2)

Explain **one** advantage to the user of having this in **one** of your named products (2)

What is D30?

List two different SMART materials, and describe how they could benefit the user on a product of your choice
Material and product: (1)

Reasoning: (2)

Material and product: (1)

Reasoning: (2)

Kevlar (Aramid)
Name two products that use Kevlar.
Is this a fibre composite? Y/N

The aramid fibres in Kevlar have a very high tensile strength. How does this help to make tyres puncture proof? (3)