

Core Technical Principles Developments in New Materials

A: Smart Materials

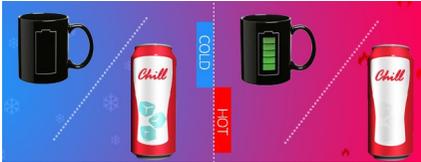
Materials that have one or more properties that can be changed in a controlled fashion by external stimuli. For example, stress, temperature, moisture, light or pH. They often return to their original state when the stimulus is taken away.

B: Thermochromic pigments

Thermochromic materials change colour at specific temperatures. They are available as plastic, ink and dyes for textiles and paint.

Uses:

- test strips on batteries
- babies feeding spoons that change colour if the food is too hot
- novelty mugs that change colour when a hot drink is put in them
- plastic strips used as thermometers that are used on children's foreheads
- colour indicators on drinks cans to show if the contents are cold enough
- t-shirts that change colour



C: Shape memory alloys

If materials made from shape memory alloys (SMAs) are bent or deformed, they will return to their original shape when heated. An example of an SMA is nitinol.

Used when:

- a response to a change in temperature is needed e.g. in a fire alarm system
- movement is needed from an electrical current e.g. in electric door locks; the temperature change can be achieved by passing an electrical current through a wire
- a damaged product needs to be easily repaired e.g. if someone bends a glasses frame it can be returned to its original shape by being heated.



D: Composites

Materials made from two or more different materials which combine the properties of the materials they are made from.

Composite	Made from	Properties	Uses
Glass reinforced plastic (GRP)	Glass fibres that are coated in a thermosetting plastic resin	Tough, not brittle, heat-resistant, easy to mould into complex shapes	Boats, kayaks, surfboards, some car bodies, PCBs
Carbon fibre reinforced plastic	Carbon fibres that are coated in a thermosetting plastic resin	Very high strength-to-weight ratio, high quality finish, expensive	F1 racing cars, sports equipment, laptops, bulletproof vests medical applications
Concrete	A mixture of cement, sand and stones; water is added during the manufacturing process	Very good compressive strength, steel reinforcing can be added to give it good tensile strength	Buildings, bridges, street Furniture e.g. bollards

E: Photochromic pigments

Photochromic materials change colour if the level of light changes.

Uses:

- lenses in sunglasses that become lighter or darker depending on the light conditions
- security markers that can only be seen in UV light
- printing designs on clothes that only show up in sunlight



F: Technical Textiles

Textile materials and products that are manufactured for their technical and performance properties rather than their aesthetic characteristics.

G: Conductive fabrics

Fabrics that have either conductive fibres woven into them or conductive powders impregnated into them. These are often called electronic textiles or e-textiles.

Uses: integrating electronics into clothing, touchscreen gloves



H: Fire-resistant fabrics

These have multiple uses including items that are often exposed to flames, such as fire-fighter's suits but also for children's nightwear and household furnishings. Nomex is a brand name for a fire-resistant fabric made from a type of polymer called a meta-aramid. It thickens when heated, increasing protection while staying supple and flexible so it doesn't impair movement.

I: Kevlar

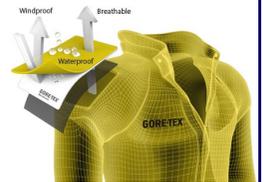
A material formed by weaving together two types of threads to create an incredibly strong material. When layers of woven Kevlar are combined with layers of resin, the result is a very light material that is resistant to abrasions and has a very high tensile strength.

Uses: bullet proof vests, motorcycle safety clothing, inner linings for bicycle tyres, protective face masks.



J: Gore-Tex

This has been designed to be a waterproof yet breathable textile. It contains a layer of plastic based on PTFE (Teflon) which contains lots of tiny pores. Each hole is too small for water droplets but big enough for sweat to pass through, making a 'breathable' fabric which can also be combined with insulation to make outdoor clothing that blocks the wind and keeps you dry and warm.



K: Microfibres

A microfibre is a very thin synthetic fibre. Microfibres are breathable, durable, crease resistant and easy to care for.

Uses: sportswear, lingerie, shirts.

Some microfibres incorporate **microencapsulation**, this means the very thin fibres hold chemicals in tiny capsules. These capsules gradually break, releasing chemicals like perfumes, insecticides or antiseptics.

Uses: insect repellent clothing, antibacterial socks

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L: Keywords

- Smart material: a material that changes its properties in response to changes in its environment
- Composite: a material that combines the properties of the materials that were used to make it
- Technical textiles: textile materials and products that are manufactured for their technical and performance properties
- Microencapsulation: very thin fibres hold chemicals in tiny capsules, which break open releasing the chemicals

M: Video and web-links

- GCSE bitesize: <https://www.bbc.com/bitesize/guides/zfq8jty/revision/2>
- smart and modern materials: <https://www.youtube.com/watch?v=FgrlDibPmJo>
- composites: <https://www.youtube.com/watch?v=WYqCnEvTRUQ>
- carbon fibre: <https://www.youtube.com/watch?v=mRefml7THbY>
- technical textiles: <http://www.julieboyd.co.uk/lets-learn/lets-learn-activities/lets-learn-resources-for/science-in-dt/materials--components/modern-materials/technical-textiles/what-are-technical-textiles.html>

Revision Checklist

I can recognise and characterise different types of smart materials

I can recognise and characterise different types of composites

I can recognise and characterise different types of technical textiles

I understand how the physical and working properties of a range of smart and new materials affect their performance

I can identify the uses of a range of smart and new materials

Test yourself

1. Name two properties of graphene.
2. Give an example of a product where Kevlar may be used.
3. Explain what composite materials are and why they are developed.
4. Explain what is meant by the term 'smart material'.
5. Give an example of a product in which photochromic pigments may be used.
6. Discuss the advantages and disadvantages of corn starch polymers.
7. Name a composite material and give an example of its use.
8. Explain how microencapsulation works.
9. Explain why Nomex is a suitable textile to make fire-fighters uniforms.