

GCSE AQA Design and Technology

Materials and their properties– Smart & Modern Materials

What you need to know:

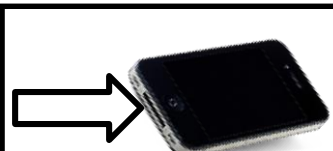
- To be able to identify a range of smart & modern materials.
- Understand what they do, their properties and the functions they provide.

What is a SMART material?

- A 'smart material' can be defined as a material whose physical properties change in response to an input e.g. making them simpler or safer to use.
- A smart material reacts to external stimulus / changes in the environment without human intervention.


Designers and manufacturers are utilising SMART materials in a whole range of mass consumer products which often makes them simpler or safer to use.

SMART Material	Property
Hydrochromic Ink	Changes colour with water
Thermochromic Pigment/ Paint	Changes colour with heat
Photochromic Material/ Dye	Changes colour with light
SMA - Shape Memory Alloy	Changes shape with heat
Phosphorescent Material	Glow in the dark
QTC – Quantum Tunnelling Composite	Soft Electrical Switch
Polymorph	A thermoplastic use for prototyping which can be reheated and reused

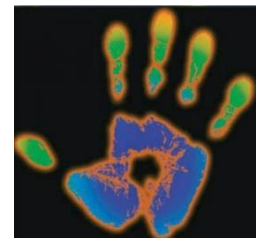


Hydrochromic paint is added to the charger socket of the Apple iPhone so Apple knows when there has been water damage which voids the warranty.


Phosphorescent Materials absorb day light, store it and release it during periods of darkness. This has been extensively used for safety lighting, signage, watch faces and those glow in the dark stars kids have on their bedroom ceilings.



Thermochromic paints can be added to any surface like these mugs or a textiles or card based product to react to heat.






Polymorph is a clever thermoplastic which we can use for prototyping and is especially useful when it comes to modelling ergonomic grips. As it is thermoplastic you can reheat and reuse this material as many times as you wish.

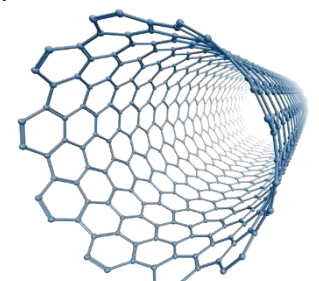


Thermochromic pigments are added to plastics and react to specific temperatures. One use is enhancing the safety of a baby's bowl.

Compostable plastics are biodegradable which are compostable & come from renewable raw materials like starch (e.g. corn, potato or tapioca). Polylactic acid (PLA), is made from fermented sugars, found in starch.



Nanomaterials are between 1 and 100 nanometres (A nanometre is one thousand-millionth of a metre). Nanomaterials include carbon nanotubes, fullerenes and quantum dots. Nanomaterials are used in car manufacturing to create cars that are faster, safer and more fuel efficient. They can also be used to produce more efficient insulation and lighting systems. They are also used as thin films or surface coatings, on computer chips.




QTC (Quantum Tunnelling Composite) is a simple soft switch material that allows an electrical current to flow when compressed. We can use it in children's toys or in many textile products such as the jacket right >



Photochromic pigments react to changes in light. One example is reaction lenses that darken with sunlight.



Metal foams are porous metal structures made from aluminium and titanium. They are strong, lightweight, electrically & thermally conductive and absorb sound well. They are made by injecting gas into the liquid metal but still retain many properties of the original metal including being recyclable.




What is a MODERN material?

- Modern materials are technical materials which have been manufactured for function.

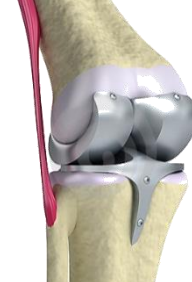

A good designer will utilise and exploit these materials where appropriate and keep up-to-date with the latest technological developments.

Modern Material	Property
Graphene	Is stronger than steel, flexible, conducts heat and electricity
Titanium	Is strong compared to its weight and is anti-corrosive
Metal foams	Are strong, lightweight, electrically & thermally conductive
Nanomaterials	Nanomaterials are between 1 and 100 nanometres.
Fibre Optics	A hair like strands of pure glass designed to transmit signals
Corn Starch Polymers	Compostable plastics which are biodegradable




Shape Memory Alloys change shape easily but always return to their original shape when they are heated. There are many applications such as dental braces and unbreakable spectacles.

Titanium is a very versatile metal. It is usually alloyed with other metals to enhance the properties. Pure titanium does not react to the human body and is used extensively in medical procedures such as artificial joints and dental implants. It is strong compared to its weight and is anti-corrosive.

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Graphene is a 2D material a honeycomb lattice carbon structure only one atom thick (a million times finer than a human hair) It is 200 times stronger than steel, very flexible, conducts heat and electricity, and is almost transparent. It is impermeable to all known substances. Electronics and energy storage could be revolutionised.