

FACTFILE: GCSE

Technology and Design

UNIT: 1.8 – SMART MATERIALS



Smart materials

Learning Outcomes

You should be able to:

- demonstrate understanding of smart materials with specific reference to thermochromic pigments and self-cleaning glass.

Traditionally materials such as wood, metal and plastic have been used for their properties of strength, durability, hardness, transparency, malleability and aesthetics etc. Imagine materials that could transform their properties from one state to another e.g. transparent into opaque, or malleable into rigid, or durable into biodegradable.

Smart materials are a new and growing area of technology where materials are designed to solve new and old problems. Designers can visit old problems and introduce new smarter materials to provide a more efficient solution. Smart materials are providing new opportunities for design and innovation.

Smart materials are:

1. Materials that are designed and manufactured to contain special properties.
2. Materials that can change from one state to another.
3. Changes are activated by environmental or direct stimulus.
4. Stimuli include temperature, moisture, electrical, magnetic, Ph, stress conditions and light.

Two common smart materials are:

1. Thermochromic pigments
2. Self-cleaning Glass

Thermochromic pigments

Thermochromic pigments are liquid crystals that change colour when the temperature changes. They can be designed and manufactured to change to one colour at a specific temperature, or to show different colours through a range of temperatures. Thermochromic crystals can be added as pigments to paints and inks, and used in a variety of applications.

One application for thermochromic pigment is for a temperature gauge or thermometer. The thermochromic pigments are designed so that each temperature is represented by a different colour. These can be used for testing body temperatures or used on fridges or freezers. The bright coloured pigments are easy to read at each temperature. This excludes the need for reading a small set of markings, as is required in a traditional thermometer.



The indicator strips on batteries appear to show

the level of electricity remaining in a battery. What is happening is a clever use of thermochromic pigments. When two fingers are placed on the white dots of the battery they complete a circuit. A resistant strip running underneath a thermochromic film heats up and stimulates the pigments to reveal a colour.

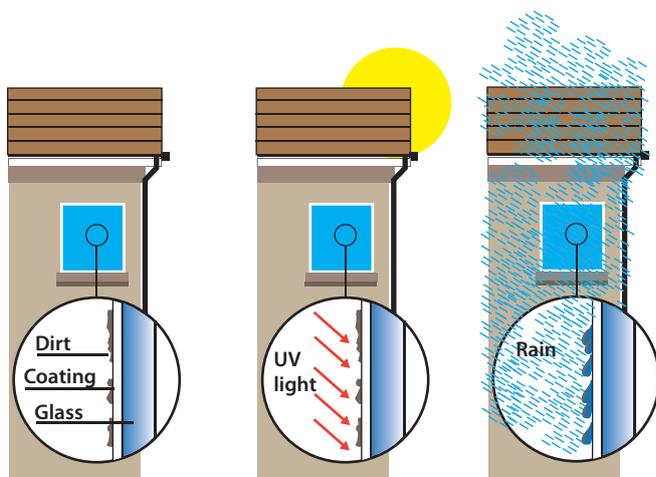


Batteries with power check indicator strips

A common example of the use of thermochromic pigments is on novelty coffee mugs. The mugs are designed to change colour from opaque to clear and reveal an image. When a hot liquid such as coffee is poured into the mug, the thermochromic paint on the outside is stimulated by the heat and changes opacity from black to transparent, revealing an image underneath.

Self-cleaning glass

Self-cleaning glass is made from a special invisible coating material to cover the glass. The coating performs two functions, one breaking down dirt and grime that stick to the glass, and other allowing rain to wash it clean.



The coating on the surface of the glass reacts to the ultra violet light from the sun. This reaction breaks down particles of dirt that are stuck to the surface of the glass making them easier to move.

The coating is also water repellent so that rain water gathers in droplets and rolls off the glass, picking up small particles of dirt as they move.

Self-cleaning glass eliminates the need to manually clean the glass. This cuts the cost of hiring cleaners, and saves money over its life time.

Additionally, as buildings are progressively getting taller and glass is being used in more extreme places. Glass can be difficult to reach and it requires specialist industrial cleaners who are trained in high rope climbing and abseiling. These situations are high risk for the cleaners, they are expensive to hire, and they could take additional time if hampered by poor weather conditions.



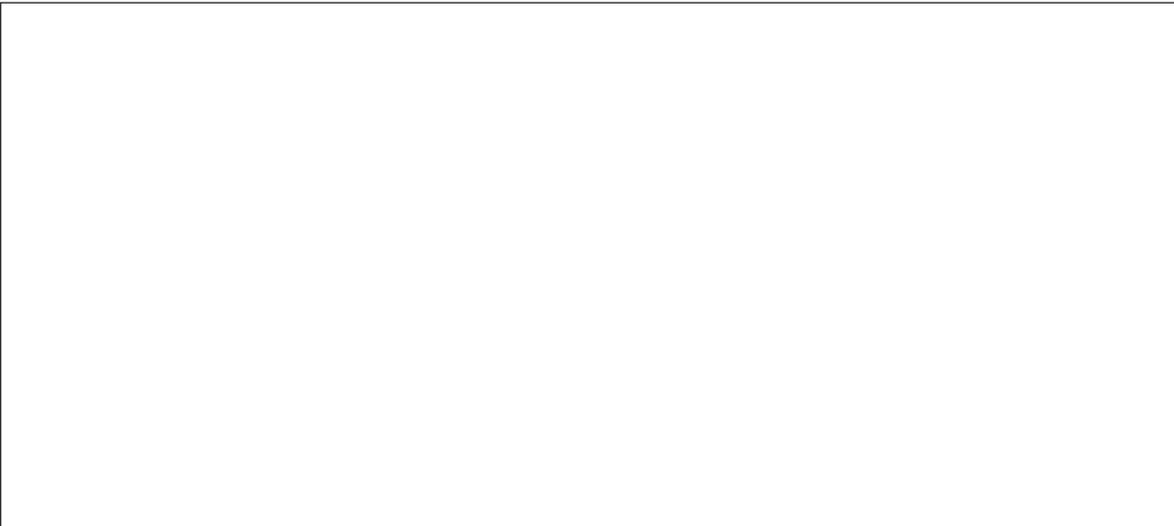
This picture shows highly skilled rope climbing cleaners dangling over an edge to clean the windows with soapy water and sponges.

Revision questions

1. What is meant by the term 'smart material'?

2. What is meant by the term stimuli?

3. Illustrate how self-cleaning glass works.



4. Summarise how thermochromic pigments work.

5. How can the high price of self-cleaning glass be justified on a tall glass structure?

6. The table below shows products that could benefit from using a smart material. Label which smart material (Thermochromic pigment or self-cleaning glass) could be used and explain what purpose it would have. Some of situations use both smart materials.

<p>Greenhouse</p> <p>Smart Material: _____</p> <p>Purpose: _____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>	<p>Baby's bottle</p> <p>Smart Material: _____</p> <p>Purpose: _____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>	<p>Solar panel</p> <p>Smart Material: _____</p> <p>Purpose: _____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>
<p>Car Windscreen</p> <p>Smart Material: _____</p> <p>Purpose: _____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>	<p>Street light</p> <p>Smart Material: _____</p> <p>Purpose: _____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>	<p>Baby food spoon</p> <p>Smart Material: _____</p> <p>Purpose: _____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>
<p>Hot water kettle</p> <p>Smart Material: _____</p> <p>Purpose: _____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>	<p>Conservatory room</p> <p>Smart Material: _____</p> <p>Purpose: _____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>	<p>Baby's bath</p> <p>Smart Material: _____</p> <p>Purpose: _____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p>

Past Paper Questions

(a) Name **two** smart materials and suggest a use for each.

Smart material 1 _____

Use _____

Smart material 2 _____

Use _____

(b) For each smart material above outline a main property.

Property (Smart material 1) _____

Property (Smart material 2) _____

(c) In what way has the development of smart materials offered product designers new opportunities?

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