

## Task 1: What is meant by the term 'smart' material?

*Definition : Smart materials react to changes in their environment.*

*Smart systems are products designed to react to changes in their environment.*



Smart materials can respond to:

- Heat
- Light
- Moisture
- Electric/ magnetic fields / Wi Fi

*Smart materials can be grouped by how they react to their environment.*

- *Colour-changing materials*
- *Light-emitting materials*
- *Moving Materials*
- *Temperature-changing materials*
- *Thickness-changing materials*

# Colour Changing Materials

## Thermochromic

T-shirts with novelty images printed on them sense and **react to heat** then change colour.



This is called **thermochromic** colour printing.



## Photochromic



The dye in military uniforms may sense and **react to light** by changing colour, increasing the camouflage.

This is called **photochromic** dyeing.



## Hydrochromic

Baby's nappies can be made to sense and react to moisture before changing **colour**. (Solvation Chromism)



## Lesson Objectives:

- Understand that the development of smart materials allows the designer to meet a variety of user needs in new and exciting ways.
- Have an insight into the range of smart materials available to a Designer in the 21<sup>st</sup> century, and their commercial impact.



# Light Emitting Materials

**Electroluminescent Materials** – can produce brilliant light when an electric current is passed through. Light generated in this way produces no heat.  
Uses: Clothing, illuminate emergency exits.

**Florescent Materials-** produce light when exposed to UV-rays.  
Uses: Clothing, Paint.

**Phosphorescent Materials-** produce light as a result of being exposed to a light source.  
Uses: Emergency warning signs, Clothing, Novelty decoration.

Revision Y11



## Lesson Objectives:

- Understand that the development of smart materials allows the designer to meet a variety of user needs in new and exciting ways.
- Have an insight into the range of smart materials available to a Designer in the 21<sup>st</sup> century, and their commercial impact.

# Moving Materials

**Piezoelectric Materials-** generate electricity when deformed by mechanical pressure .

Uses: Sensors (e.g. Alarm systems), low quality speakers (i.e. talking greetings Card), & Smart Skis (reduce unwanted vibrations).



**Quantum Tunnelling Composites (QTC) –** A polymer containing small particles of metal. This material is normally an insulator, but when compressed it becomes a conductor of electricity.

**Uses: Sensitive switches to control electrical devices in clothing.**



**Shape Memory Alloy (SMA's) – Alloy of Nickel & titanium = Nitinol**

Metal that after being strained return back to the original shape at a certain temperature.

Uses: Stents (tubes threaded into the arteries expand on heating to body temperature, to allow increased blood flow). Air conditioning units.

## Lesson Objectives:

- Understand that the development of smart materials allows the designer to meet a variety of user needs in new and exciting ways.
- Have an insight into the range of smart materials available to a Designer in the 21<sup>st</sup> century, and their commercial impact.

Revision Y11



# An interactive jacket



It has a built in PAN - Personal Area Network that you can use to route your earbud cables. In the inside collar area, a piece of the quilted material is held in place with Velcro. Opening this channel will allow you to place your earbud cables so that you can easily access your music while on the go.

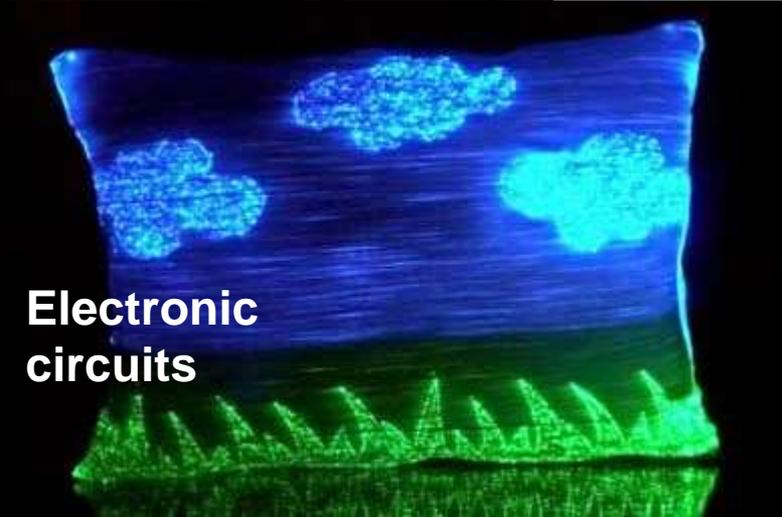


**Glow in the dark**

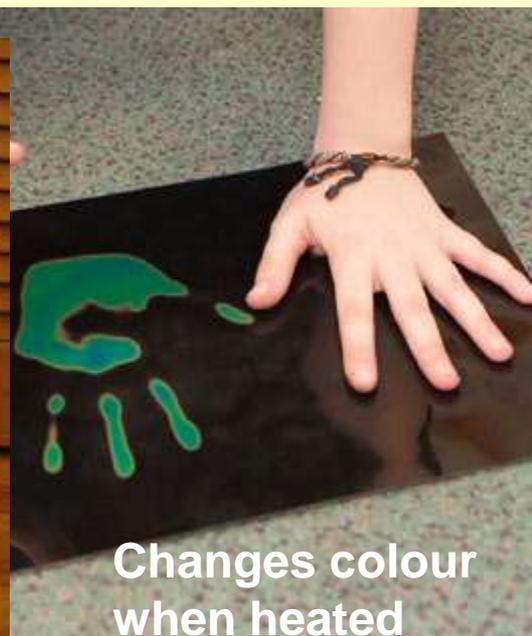
**GPS plug in /  
earphone socket**



**Flashing lights**



**Electronic  
circuits**



**Changes colour  
when heated**

## Smart and modern materials

How are modern fabrics 'modern'?

By being **interactive**, and needing a **power source** to make them smart.

Metallic threads are used to conduct the power.

Soft, flexible circuits and switches are used.

Solar power or batteries may be used.

A camera in a paramedic's hat can inform doctors about the casualty before arriving at hospital.



Motorcycle clothing that can heat up, to keep the rider warm. Gloves may have lights for increased visibility.



Where are these interactive modern materials with a **power source** used?

Active clothing that can monitor your performance.



Some modern materials don't have a power source, such as **biomimetics**. Biomimetic means '**mimicking nature**'.

Scientists have studied nature for inspiration when developing modern materials.

**Fastskin** is a product that mimics shark's skin, and is used for swimwear.

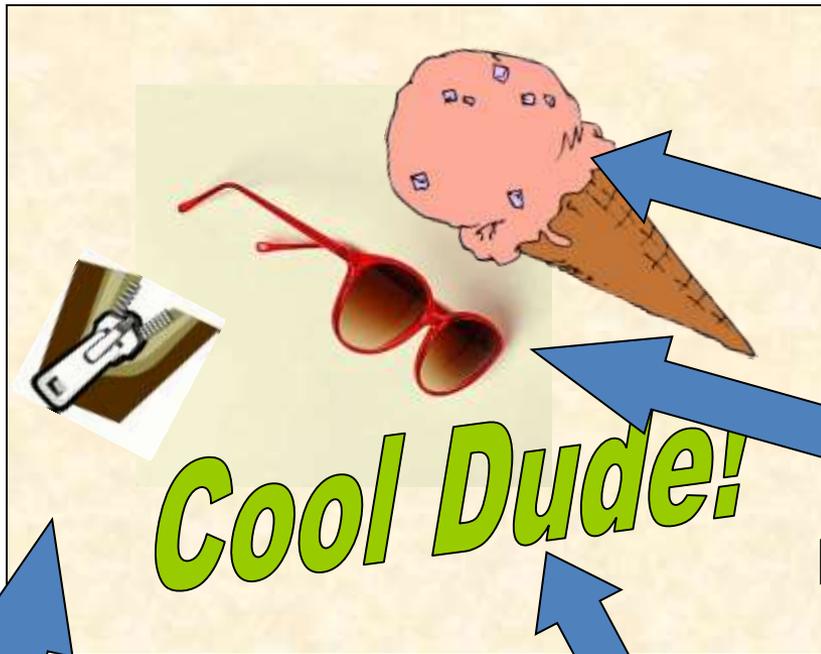
**Glow-in-the-dark fabrics** mimicking phosphorescent jellyfish are often used for children's products.

**Velcro** was designed to mimic seed burrs hooking onto dog's fur. It is now a popular fastening fabric.

### Key word definitions

- **Smart Textiles**: materials that can react to changes in their surroundings.
- **UV reactive** = threads or a textile print that change colour when exposed to sunlight – ultraviolet light = sunburn.
- **Thermochromic** = change colour when they warm up/ cool down
- **Glow in the dark**: a textile that contains a phosphorescent pigment that when charged by light, will glow in the dark
- **Microencapsulation**- minute particles of fragranced chemical trapped in the print paste = scratch & sniff fruit character tee shirts, magazine perfumed pages

# Smart cushion designs...



Strawberry fragranced ice cream print, Appliqué cone

Heat transfer image - sunglasses

Glow in the dark embroidery thread

Tie Dye background – cotton fabric

# Key word definitions - can you recall?

- **-m--- --x-il-s**: materials that can react to ----- in their surroundings.
- ----- threads or a textile print that change -----when exposed to sunlight – **ultraviolet light = sunburn.**
- -----**chromic** = change colour when they warm up/ cool down
- **Glow in the dark**: a textile that contains a
- ----**phorescent pigment** that when charged by -----, will glow in the dark
- -----**encapsulation**- minute particles of fragranced chemical trapped in the print paste = scratch & sniff fruit character tee shirts, magazine perfumed pages

# What are Smart Materials?

- Smart materials are materials that have one or more properties that can be significantly altered in a controlled fashion by external stimuli.

Examples include stress, temperature, moisture, pH, electric or magnetic fields.

# Examples!



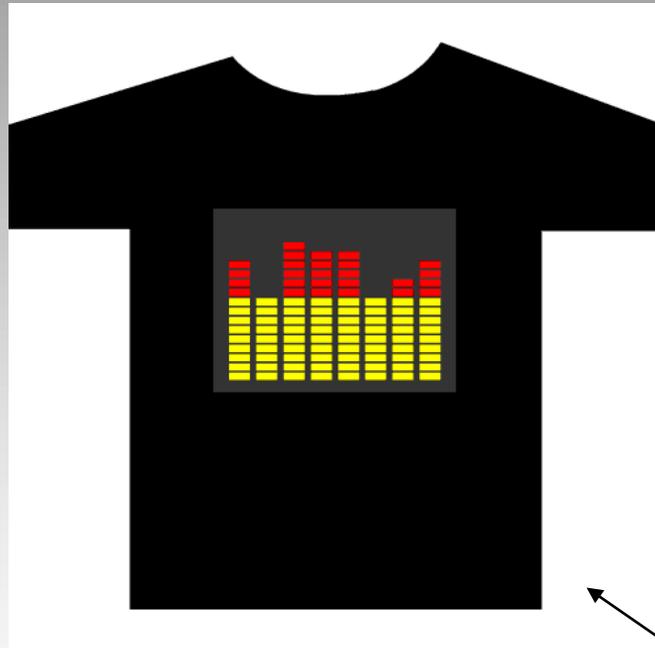
Burton Snowboards wanted to develop a system to make it easier for snowboarders to listen to music (on a personal stereo) while boarding. They approached Softswitch Ltd to develop a electronic textile control pad for the Apple iPod system, which could be integrated into the sleeve of a Burton snowboarding jacket. The successful development of this wearable electronic system, involving the use of electrically conductive polymers, yarns and fabrics was named as one of Time Magazine's Coolest Inventions.





Made of soft, washable fabric, woven with optical and electrical fibres into it, the 'Smart shirt' monitors the wearer's heart rate, body temperature, respiration and a host of other vital functions. The information can be relayed wirelessly to doctors or personal trainers. Future applications include shirts for parental use to monitor babies and for military use to provide a trapped soldier's exact location and give support units exact information about wounds.

# Examples you may have already seen?!



These examples can be found in shops all around the country!

# Kevlar

Kevlar is a versatile material which is strong, tough, stiff, high-melting and well suited for uses such as radial tyres, heat- or flame-resistant fabrics, and bullet-proof clothing



# Micro encapsulated fabrics



Scents and smells can be added to fibres that can be released slowly - here's an example of a child's toy that has been fused with Chocolate scent - more aroma is released through heat.

Other examples include the scratch and sniff T-shirts and packaging.

# Fabrics you should be aware of!

- **Polartec** - made from recycled Polyester (plastic drinks bottles). Its light-weight and breathable
- **Gore-tex** - is a bonded fabric that combined with other fabrics in thin layers provides exceptional properties including Wind/water proofing. It will also let the skin breath so is excellent for outdoor protective clothing
- **Neoprene** - is a man made fabric, used for wetsuits and other water sports attire. Has a stiff, body hugging quality that seals body heat in for protection

## Miss Wade's guide to getting it right!

It is likely that a question will pop up on **smart materials** and fabrics therefore take my advice and really revise **4 good examples** of smart fabrics - think about why they are **good**, the **types of properties** they have and **where** they have or could be **used**.

I would also be prepared to know about different fibres/fabrics

Just make sure you know all the **natural fibres** and at least **3 examples** of **regenerated** and **synthetic fibres** too!

Test yourselves with the *GCSE Bite size* revision guides - they are quite good! 😊