# D&T Smart Materials Knowledge Organiser.

## SMART MATERIALS SMART

materials are those that change in reaction to change in conditions in their surroundings for example changes in temperature and light or in their use when influenced by controlled factors - such as passing an electric current through them.

Modern products increasingly use them as imaginative designers see the potential they offer.

Shirts that change colour with changes in temperature and thermometers that are in the from of printed strips use **thermochromic inks.**
**photochromic inks** respond to changes in light conditions. Clothing also uses the inks that have this characteristic and have patterns that change with altering light conditions.

Materials that respond to an electric current might be used as component parts of safety valves or as a part of a functional system that uses the change in shape with current to trigger some other process. These are **'shape memory alloys' (SMA) or (Nitinol) . Thermoelectric** materials again use electrical current but change temperature - in this way cooling or heating can take place and this effect is being used to design innovative products that can move when temperature changes or electricity is added. The electricity can be used to increase the temperature of the metal and this causes the change

Polymers that change their shape with changes in temperature are sometimes called **'Intelligent gels**' - It is only imagination that limits the products that might be created as more such materials are developed.

SMART materials have one or more properties that can be dramatically altered. Most everyday materials have physical properties, which cannot be significantly altered; for example, if oil is heated it will become a little thinner, whereas a smart material with variable viscosity may turn from a fluid which flows easily to a solid.

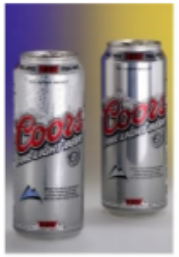
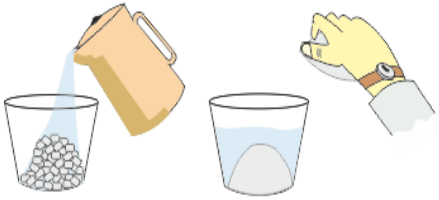
A variety of smart materials already exists, and are being researched extensively. These include

- **piezoelectric materials**,
- **magneto-rheostatic materials**, **e**
- **electro-rheostatic materials**,
- **shape memory alloys**.

•Some everyday items are already incorporating smart materials (coffeepots, cars, the International Space Station, eyeglasses) and the number of applications for them is growing steadily. Each individual type of smart material has a different property which can be significantly altered, such as **viscosity, volume,** and **conductivity**. The property that can be altered influences what types of **applications** the smart material can be used for. For some time now, scientists have been researching materials, which – equipped with sensors and controls – "behave" similarly to biological systems. Initial successes with these kinds of "smart materials" have already been achieved. As a result, materials could soon be available which repair themselves or adapt to certain environmental conditions **autonomously**.

**Material Classification - SMART MATERIAL**

| Material | Material Properties | Material Characteristics | Uses | Examples |
|---|---|---|---|---|
| SMA<br>Shape Memory<br>Alloy [NITINOL] | Returns to its original shape if deformed e.g. frames for memo flex glasses spring back into shape if the frames are bent or sat on accidentally. | Material remembers its original shape if deformed and will return to original state. | • Teeth Braces<br>• Frames for Spectacles |  <br>  |
| Photocromic Glass | This Glass changes colour when subjected to light.<br>Glasses that darken when in sunlight. Welding Masks that instantly darken when you weld. | The pigment in the glass will react to light and change its property and darken. | • Glass on welding masks that reacts instantly when welding<br>• Lenses on expensive sunglasses |  <br>  |
| Thermochromatic Material | This material will change colour when subjected to different temperatures. For example kettles that change colour when hot. Children's spoons. Bath plugs for babies. | The change in colour happens at a determined temperature, which can be varied depending on the material. | • Smart colour pigment in plastics that react to heat |  <br>  |

| Material Classification - SMART MATERIAL | | | | |
|---|---|---|---|---|
| **Material** | **Mechanical Properties** | **Material Characteristics** | **Uses** | **Examples** |
| Thermochromic Ink | Ink pigment that reacts to heat. This ink pigment can be used on products as indicators of heat. | Thermochromic ink in the material will change colour when material is subjected to temperature change. | • Ink on beer cans that show if the beer is cold.<br>• Ink on eggs that change colour if egg has been boiled for long enough |   |
| Piezoelectric Materials | Material will deform when a small electric current is passed through it. It will also produce a small voltage when deformed. | This material can be ceramic or crystal (Quartz) based. | • Contact sensors<br>• Alarms<br>• Microphones and headphones |   |
| Polymorph | Polymorph is a thermoplastic material that can be shaped and reshaped any number of times. it is normally supplied as granules that look like small plastic beads. it can be heated in hot water and when it reaches 62 degrees centigrade the granules form a mass of 'clear' material. | When removed from the hot water it can be shaped into almost any form and on cooling it becomes as solid as a material such as nylon | polymorph is suitable for 3D modelling as it can be shaped by hand or pressed into a shape through the use of a mould. |  |