Rewarding Learning

AS LEVEL Section D

FACT FILES

Technology & Design

For first teaching from September 2011

For first award in Summer 2012

Materials Part 1

technology and design

FACT FILE

1.28 Materials Part 1

Learning Outcomes

At the end of this unit students should be able to: Demonstrate knowledge, understanding and applications for the following modern materials:

- Thermochromic and photochromic materials;
- Phosphorescent pigments;
- Reflective films and holograms and;
- Bio-degradable plastics.

Course Content

What are Thermochromic materials?

Thermochromic materials change colour at specific temperatures. A change in temperature causes the liquid crystals to re-orientate which brings about the change in colour. They are incorporated into a special ink and printed onto plastic films to create thermometers or temperature indicators. The battery test strip is a good example. If a battery has good life in it, the current flows through a printed resistor under a thermochromic film which heats up to cause the colour change. The liquid crystal material itself is contained within microscopic spherical capsules which are used to make paints, inks or are mixed to moulding for different products.

There are two main types of materials used to produce thermochromic effects. These are:

- liquid crystals, and;
- Organic dyes known as leucodyes.

Liquid Crystals

Thermochromic liquid crystals give a relatively accurate measurement of temperature; and as a result this allows them to be widely used in such things as strip thermometers, mood rings and LCD displays on calculators.

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Leucodyes

Leucodyes are organic chemicals that change colour when heat is applied to them, this makes the molecules in the leucodyes move between two structures known as colourless 'Leuco' or coloured 'non Leuco' both of these structures reflect light differently. Leucodyes are temperature sensitive dyes or inks which start off as a particular base color but change space as the temperature rises or falls. Leucodyes are used on novelty items e.g.: Tshirts, coffee cups, and till receipts

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What are Photochromic materials?

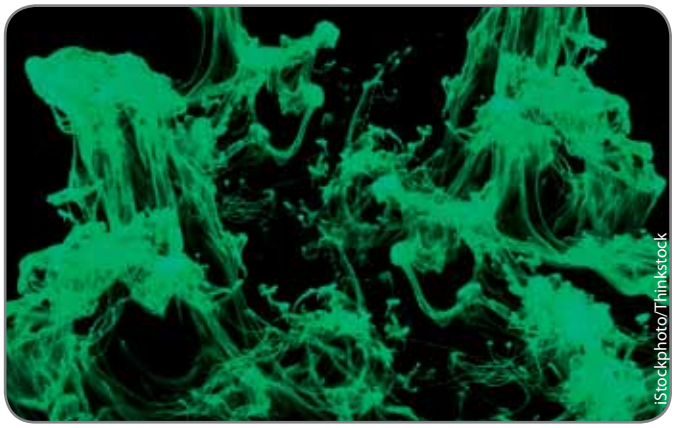
Photochromic materials are materials that undergo colour changes induced by exposure to different lighting conditions and are used for a range of products. Products as diverse as nail varnish, photochromic lenses, camera filters, smart coatings for windows, sun-blinds, specialist clothing, jewellery and large-scale sign boards utilise the technology in these materials. Photochromic materials are reactive to the UV component in sunlight, and as a result can be used as UV radiation indicators.

What are Phosphorescent Pigments?

Phosphorescence is a process in which energy absorbed by a substance is released slowly in the form of light. Phosphorescent pigments consist of very fine crystals of zinc sulfide; copper is then added to the zinc sulfide as an activator. This allows the crystals to absorb light and slowly emit it over time.

Advantages of Phosphorescent Pigments

The main characteristic of phosphorescent pigments is their capacity to absorb, store and emit light. After absorbing light they can glow in the dark for up to twelve hours. In addition the material is stable, non-toxic, has no radioactive additives and has good weatherability.



Phosphorescent Pigments Applications

Phosphorescent pigments can be used in manufacturing of paints, inks plastics, rubber and films. It is completely safe and is widely used for the following;

- clothing and shoes;
- stationary goods and escape route signs;
- watches, toys; and
- sporting goods.

What are Reflective films?

There are many types of reflective films on the market each with their own specific characteristics. Reflected films on the whole recycle light that has not reached the intended direction on its first pass, and directs it back into the system.

Reflective Films Applications

Reflective film used in windows for the commercial and domestic market can be made out of one or more layers of polyester. This film is usually installed to improve energy efficiency by lowering the amount of heat entering a building as a result of sunlight. They are used to improve privacy and shatter resistance. As well as helping to decrease the amount of ultraviolet (UV) light entering a room which can fade furnishings and fabrics.

Innovative reflective films can be applied accurately and at speed to ensure high visibility and branding for emergency service vehicles for fire police and ambulance.

What are Holograms?

A hologram is a flat surface that, under proper illumination, appears to contain a three dimensional image. Holograms are made up of multiple two dimensional layers with images placed one behind the other to produce a three-dimensional structured effect.

Types of Hologram

The three most common types are:

- reflection;
- transmission and;
- embossed holograms.

Reflection holograms are illuminated by a white light source on the viewing side of the hologram. The light is reflected from the hologram to show the image. Transmission holograms are viewed by illuminating from the rear with a laser. The advantage of transmission holograms is that they can be very sharp, loaded with detail and the image can have great depth. Finally the Embossed holograms which are commonly found on consumer goods and credit cards. The hologram is embedded on a thin plastic film backed with reflective aluminum. The aluminum reflects incident light back through the hologram activating it.

Hologram Applications

Holograms have many applications they are used on certain product packaging and on magazine covers. In addition they are found on credit cards, driver's licenses, and even clothing to help stop counterfeiting.

It is possible to take flat medical images, such as a CAT scan and have the final image as a three-dimensional hologram. Engineers also use holography to test for fractures and for quality control during manufacturing. This is called holographic non-destructive testing.

The holograms used in security are very difficult to forge, because they are reproduced from a master hologram that requires expensive, specialized equipment. As a result they are used widely in many currencies, such as the British pound 5, 10, 20 notes. They are also used in ID cards, books, DVDs, and sports equipment.

What are Biodegradable plastics?

Biodegradable plastics are plastics that will breakdown in natural aerobic (composting) and anaerobic (landfill) environments. This can be achieved by enabling microorganisms in the environment to metabolize the molecular structure of plastic films to produce a material that is less harmful to the environment.
They may be composed of either

- bioplastics – plastics whose components are derived from renewable raw materials;
- or petroleum – based plastics which use an additive.

Biodegradable plastics produced by injection molded are typically in the form of disposable food service items, and films, typically for fruit packaging.

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Advantages of Biodegradable plastics

The main advantages of biodegradable products are:

- Biodegradable plastics takes less time to break down after being thrown away. This results in less plastic dominating our landfills.

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- Biodegradable plastics are made from biomass and are completely renewable resources.
- Biodegradable plastics are better for the environment, as little or no harm is done to the earth when recovering fossil fuels.
- Biodegradable plastics are easier to recycle non toxic and reduce the dependence on foreign oil.

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Disadvantages of Biodegradable plastics

There are some disadvantages to biodegradable plastic waste;

- In certain situations, when dumped in landfills biodegradable plastic breaks down under anaerobic conditions, which creates methane, a greenhouse gas.
- Biodegradable waste can contain toxins.

Revision questions

1. Outline **two** main characteristics associated with Phosphorescent pigments.

2. Distinguish between thermochromic and photochromic materials.

3. Give **two** specific applications for each of the following:
   - photochromic materials;
   - reflective films;
   - holograms and
   - bio-degradable plastics.

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