

**MODERN MATERIALS**

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# MODERN MATERIALS

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1. POLYMORPH (Some exam boards still refer to this as a Smart Material)

2. ENVIRONMENTALLY FRIENDLY POLYLACTIDE (PLA)

3. BIOPOL - BIODEGRADABLE PLASTIC

4. OXO-DEGRADABLE POLYMERS

5. FLEXI PLY

6. WHAT IS TITANIUM?

7. GRAPHENE

8. METAL FOAMS

9. NANOMATERIALS

10. LIQUID CRYSTAL DISPLAYS

# 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. In the classroom 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.

Although expensive, polymorph is suitable for 3D modelling as it can be shaped by hand or pressed into a shape through the use of a mould.

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# POLYMORPH – SHAPING BY HAND

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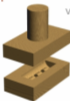
# SMART MATERIALS - POLYMORPH USING A MOULD

A mould can be made by hand by a skilled craftsman. However, CAD software can be used to design a mould and a CNC machine can then be used to cut / mill the shape.

Polymorph is a material suited to fast prototyping rather than the lengthy use of CAD software and CNC machines.

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1.



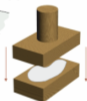
PREPARE MOULD ON  
CNC MACHINE

2.



PLACE POLYMORPH  
IN MOULD

3.



PRESS TWO PARTS OF  
MOULD TOGETHER

4.



POLYMORPH MOULD  
NEEDS TRIMMING

5.



MODEL ERGONOMIC  
SCREWDRIVER HANDLE

6.



ADD SCREWDRIVER BLADE  
FOR REALISM

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# POLYMORPH

**TAP THE LINK BUTTONS  
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ON THE MATERIAL /  
MODERN MATERIAL  
POLYMORPH**

Remember to check with your  
teacher – Your examination  
board may regard polymorph  
as a smart OR modern  
material



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## ENVIRONMENTALLY FRIENDLY POLYLACTIDE (PLA)

Polymers / plastics have a reputation of being environmentally unfriendly. They take years and in some cases centuries to decay.

However, plastic bags made from Polylactide (PLA) take only five years to decompose. Containers such as drinking bottles and food containers manufactured from PLA, take slightly longer to decay, as they are manufactured from thicker material.

**Polylactide** is referred to as a 'bioplastic' because of its environmentally friendly nature.

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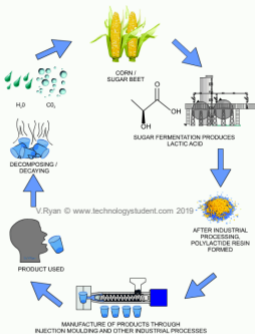
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# LIFE CYCLE - POLYLACTIDE (PLA)

It is a sustainable, environmentally friendly polymer, due to it being derived from plants.

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# BIOPOL BIODEGRADABLE PLASTIC

Biopol is a brand name for PHB (Polyhydroxybutyrate). An environmentally friendly, quality biodegradable plastic, produced through the fermentation of plant sugars and glucose, derived from sweet potatoes, pea starch, soya starch and vegetable oil. Biopol is a biopolymer, classified as a polyester and has similar properties to polypropylene (PP). Compostable, degrading harmlessly in soil.

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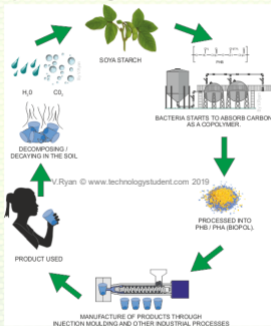
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# BIOPOL BIODEGRADABLE PLASTIC

Biopol products can be land filled and they decompose producing water and carbon dioxide.

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# BIOPLASTICS

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BELOW FOR MORE DETAIL  
ON BIOPLASTICS



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# FLEXI PLY ( A FLEXIBLE FORM OF PLYWOOD)

Flexi ply is composed of layers of thin plies.

This means that it will bend into various 'curved' shapes, quite easily.

The image, shows how layers of flexi ply can be formed into unusual shapes.

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MP3 STATION



ROCKING CHAIR



BOOKCASE



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# WHAT IS TITANIUM?

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Titanium (Ti), is a lightweight metal, that has a variety of practical applications. It has half the density of steel, making it a lightweight replacement.

Titanium has a similar tensile strength to steel and a very high melting point, 1670oC. It resists corrosion and is extremely resistant to acids and salt water.

It is non-magnetic.

Titanium is a poor conductor of heat

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# GRAPHENE

Graphene is a newly discovered two dimensional material, composed of a single honeycomb layer, a hexagonal lattice of carbon atoms. It is one atom thick and yet it is the strongest and lightest material ever tested, plus it has the highest conductive qualities of any material. Graphene has the potential to radically change our consumer world, from manufacturing processes, to many of the products we buy.

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Graphene has the potential to revolutionise the design of computers, power stations and the distribution of electricity and many consumer products.

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GRAPHENE HAS THE POTENTIAL TO IMPROVE THE EFFICIENCY OF INTEGRATED CIRCUITS



GRAPHENE HAS THE POTENTIAL TO DRAMATICALLY IMPROVE THE CONDUCTIVE EFFICIENCY OF ELECTRICAL CABLES



POTENTIAL TO IMPROVE THE EFFICIENCY AND FLEXIBILITY OF SOLAR PANELS

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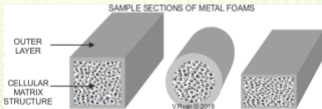
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# METAL FOAMS

Metal foams are solid structures, usually composed of a dense outer layer, with the inner portion in the form of a matrix of pores. Foams possess the property of 'porosity', allowing air/gas and even liquids to pass through them and they are based on materials with a similar structure, such as natural bone, pumice stone and natural sponges. They have an internal cellular matrix structure. Aluminium, tantalum and titanium, are the metals that are commonly manufactured as foams.

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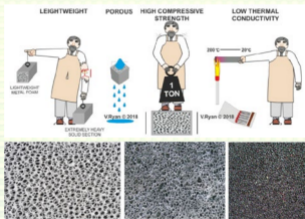


# METAL FOAMS

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Metal foams have enhanced physical properties. For instance, aluminium metal foam has an even lower thermal conductivity, than the solid or tube versions. Metal foams can be recycled in the same way as other metals.

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# THE PRACTICAL APPLICATION OF METAL FOAMS

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Metal foam is found in the frame / substructure of some cars. This saves weight, but also adds strength to critical areas and provides improved safety, in the event of a crash / accident.

Less metal is required to make the frame and yet it improves its strength and resistance to compression.

**Tap on the images** for more practical applications

A LOAD BEARING STRUCTURE  
COMPRESSIVE STRENGTH



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# METAL FOAMS

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ON METAL FOAMS



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# OXO-DEGRADABLE POLYMERS

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Oxo-degradable polymers are processed from petroleum based polymers and contain additives such as metal salts (bio-batch). When 'dumped' in a landfill site and covered with soil, the additives encourage the molecular structure of the 'plastic' to change into a food source, for micro-organisms. They bio-degrade into carbon dioxide and water. This is called an abiotic process (degradation by oxidation).

**Tap on the image** for detailed information and practical applications



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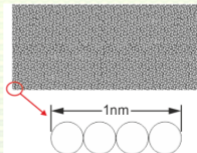
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# NANOMATERIALS

A common misconception is that nanomaterials are materials that have simply being miniaturised. The reality is that a single particle of a nanomaterial, has an average size between 1 to 100 nanometres (nm), which is extremely small. Nano means  $10^{-9}$  or 0.000000001. 1 nano is regarded as equal to the distance across three atoms. Nanomaterials possess enhanced properties, such as increased tensile strength, thermal qualities and amplified magnetic and electrical attributes.

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# NANOMATERIALS

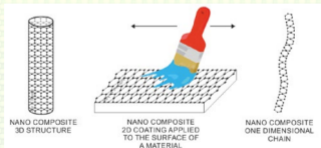
Nanomaterials have a range of practical applications. One practical application is in ultra-efficient solar panels, converting sunlight into electricity.

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Nanomaterials are being developed, that combine the properties of more than one 'parent material' and applied as a coating.

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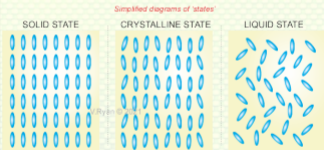


# LIQUID CRYSTALS

Once it was believed, that there were only three states of matter; solid, liquid, and gas. Today there are considered to be four states, with 'liquid crystals' being the fourth, falling between the solid and liquid phases.

Liquid crystal molecules are elongated, sometimes described as banana or rod shaped. When exposed to an electric current or magnetic field, the molecules align in a direction along a common axis, they can also form layers.

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# LIQUID CRYSTAL DISPLAYS

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There are two types of liquid crystal display, monotone and full colour. Monotone have a single colour, for example the seven segment display. The letters / numbers are dark grey or black. The background is light grey and backlit, so that the letters / numbers standout. A full colour LCD display, displays a full range of colour (see explanation of LCD TV).

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MONOCHROME LCD



FULL COLOUR LCD



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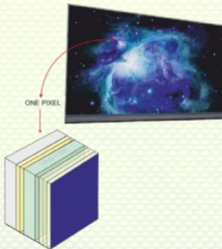


# HOW THE LIQUID CRYSTAL COLOUR DISPLAY OF A TV WORKS

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A typical LCD TV screen has 2,000,000 individual pixels. The pixels form the picture that you see on the TV screen. Each pixel can be switch 'on' or 'off' using polarised liquid crystals, creating a red, blue, or green light source. The way the pixels are controlled, produces the sharp colour image on the TV screen.

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