Bridging work for A- level Design and Technology

- *Topic area 1*
- Focusing on section 1.7 Smart and modern materials.
- Design a product which would enhance the life of a person with a disability using any one of the smart materails.
- *Topic area 5*
- Students need to learn about Design theory through the influence and methods of the following key historical movements and figures.
- Arts and Crafts- William Morris
- Art Nouveau- Charles Rennie Mackintosh
- Bauhaus Modernist- Marianne Brandt
- Art Deco- Eileen Gray
- Post Modernism – Phillipe Starke
- Streamlining- Raymond Lowey
- Memphis- Ettore Sottsass.
- For EACH of the above movements and figures you should complete a short research task.
- Include:
- Details of their life.
- Where they worked.
- What they did.
- There most influential work.
- Include images of a range of their work.
- Use the attached as a guide.

Philosophy – Stark hoped his work would improve people's lives by adding an element of humour or surprise

to everyday acts such as brushing one's teeth or cooking.

Designs – More than 10,000 designs.

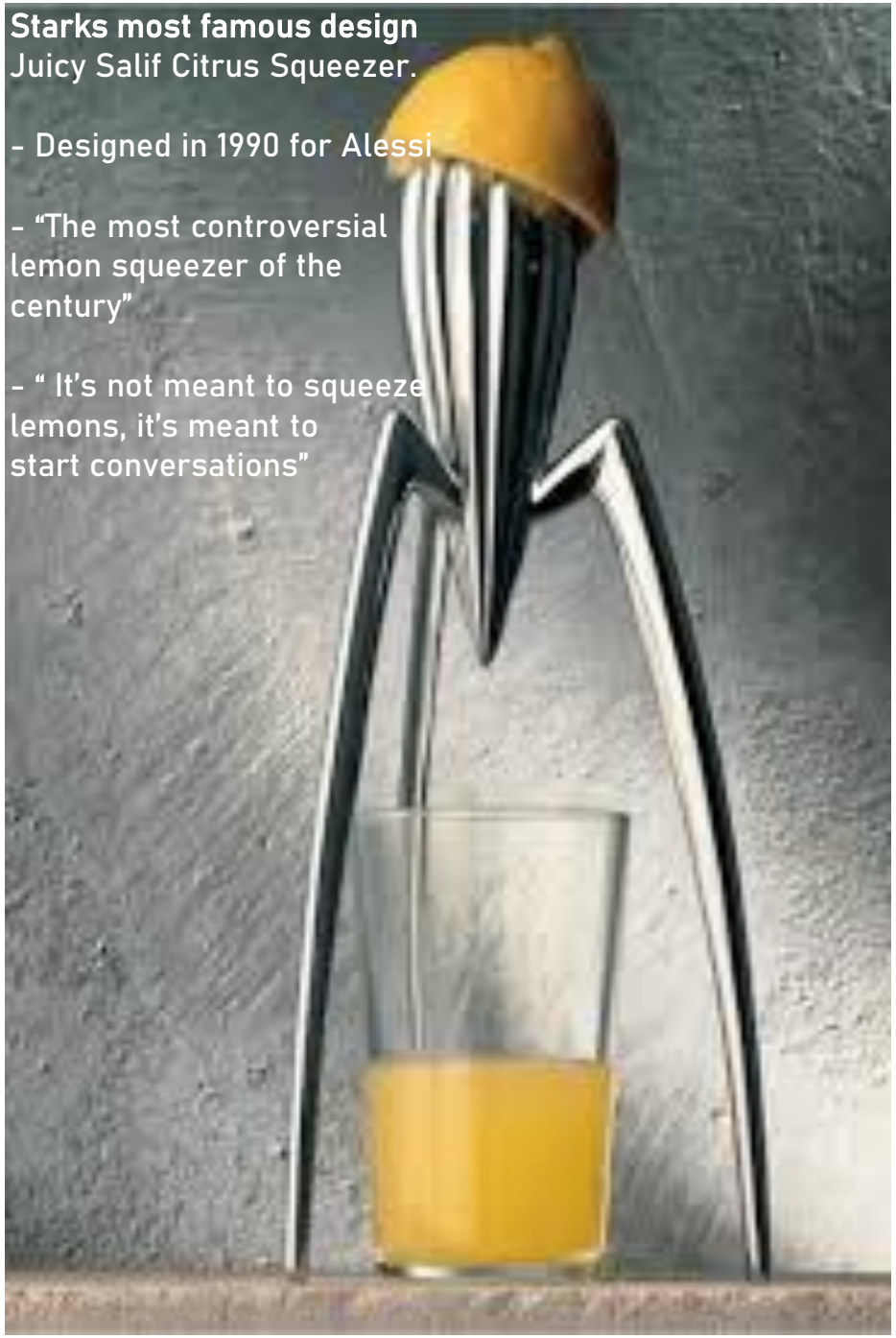
- Designs include furniture, decoration, architecture, street furniture, industry (wind turbines, photo booths), bathroom fittings, kitchens, floor, and wall coverings, lighting, domestic appliances, office equipment such as staplers, utensils, tableware, clothing, accessories, toys, glassware, graphic design and publishing, food, a and vehicles for land, sea, air and space.
- Design style, Post modern. Mass produced affordable designs.

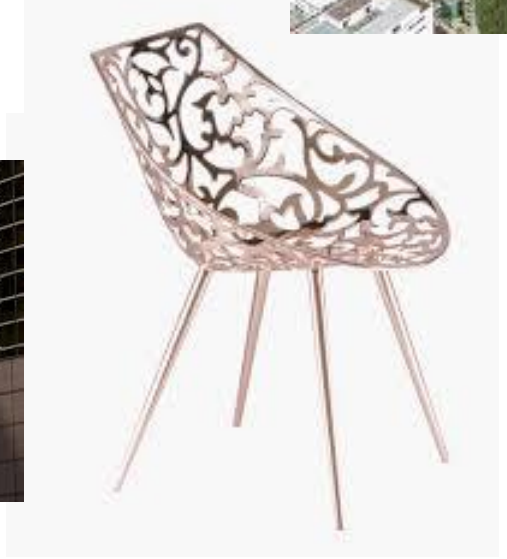
Starks most famous design
Juicy Salif Citrus Squeezer.

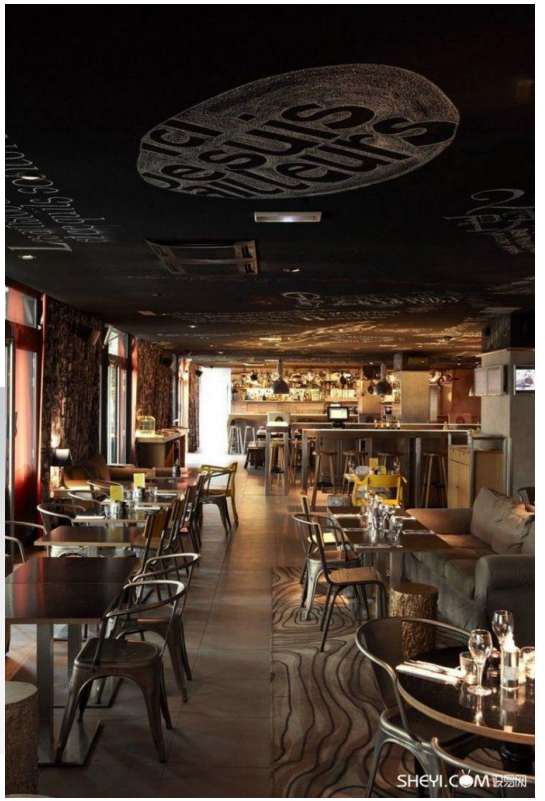
- Designed in 1990 for Alessi

- “The most controversial lemon squeezer of the century”

- “ It’s not meant to squeeze lemons, it’s meant to start conversations”







Philippe Starck

Life – Born in 1949 (72 years old)
- French
- Son of aeronautical Engineer
- Lives between New York and France.
- Net worth $34 million

Career - Studied Architecture and design at the Ecole Nissim de Camondo in 1968.
- Left Ecole Nissin de Camondo and started designing for Adidas.
- 1970 launched his own company, Stark Product, later renamed Ubix
-Worked with manufacturers including Alessi, Kartell, Drimmer, Microsoft, Puma.

First Design – 1969 The Inflatable House, this caught the eye of Pierre Cardin who gave Stark a job as an artistic director of his publishing house.


MATERIALS
BOTH MODERN AND SMART

Smart Materials

Smart materials are reactive materials. Their properties can be changed by exposure to stimuli, such as electric and magnetic fields, stress, moisture and temperature. They react to environmental conditions.

Thermo chromic Pigments

Pigments that change colour with **temperature**

Has your egg been hot enough for long enough?

A 2D temperature gauge

Useful on marketing materials

Interesting gimmicks !

Photochromic and electrochromic Materials

Photochromic inks and materials darken as the light level increases. Some photochromic materials and inks change colour. In fact, it is UV light that causes the darkening of the ink or material, which means the ink or material works best in natural light. This special ink or material has two main applications; sunglasses and spectacles. It is also used as a security marker that can only be seen in ultra violet light. **Smart glass** or **switchable glass** is glass or glazing whose light transmission properties are altered when voltage, light or heat is applied

Possible Applications:

energy-efficient windows that switch from transparent to opaque spontaneously upon exposure to increasing levels of sunlight or preventing heat loss from interiors such as homes and offices.

Electro chromic glass: changes opacity when an electrical charge is passed through it. Uses include car, aircraft, and office glass for comfort and security

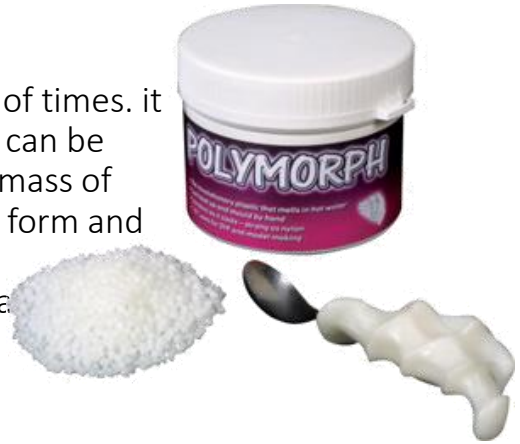
Electro-rheostatic (ER) and magneto-rheostatic (MR) materials

These fluids can change from a thick fluid (similar to motor oil) to nearly a solid substance within the span of a millisecond when exposed to a magnetic or electric field; the effect can be completely reversed just as quickly when the field is removed.

ER Applications
- Viscous clutches
- Valves
- Reduced noise engine mounts

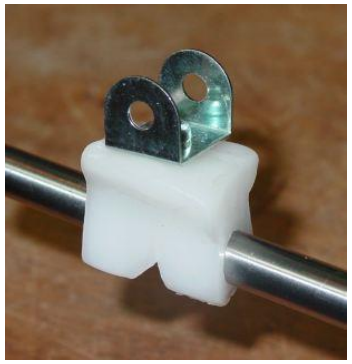
MR Applications
- car shocks
- damping washing machine vibration
- prosthetic limbs,
- exercise equipment
- surface polishing of machine parts

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 ha
[illegible] through the use of a mould



- **Supplied as granules**
- **When heated to 62 degrees or above in water they form a ply able solid**

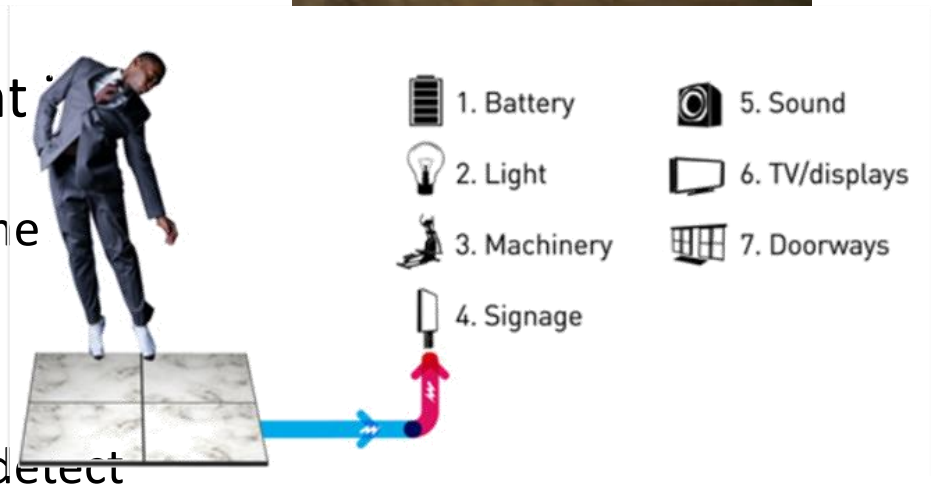
- **Useful for forming :**
  - **handles/grips**
  - **Complex shapes**
  - **Prototype patterns for casting or moulding**
  - **Completing complex assemblies**



Piezoelectric Materials

- 2 unique properties
  - When deformed, they generate a small but measurable electrical current.
  - When an electrical current is applied, they change size
    - up to a 4% change in volume
- Applications
  - Sensors
    - The airbag sensors in cars detect force of impact
  - Buzzers
  - Low quality speakers

Piezo electric buzzer

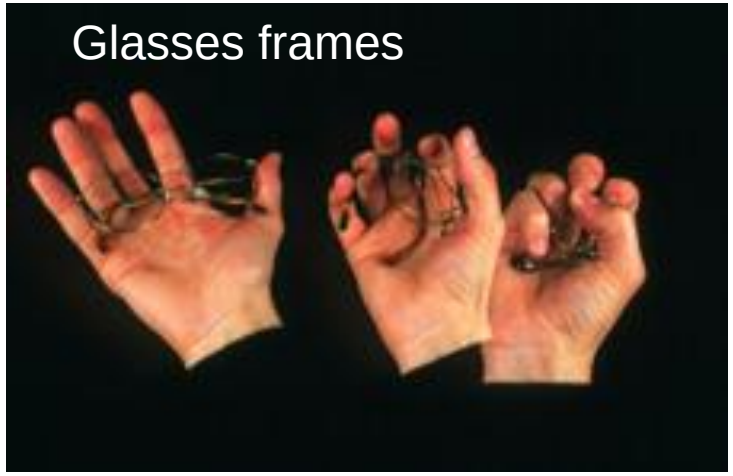


Piezo electric insert generates current to activate a warning light in the jogging shoe

Shape Memory Alloys

For most materials, if they are bent out of shape, they stay that way (plastic deformation). However, if a part made from a shape-memory alloy (**SMA**) is bent out of shape, when it is heated above a certain temperature it will return to its original shape.

This property makes it useful for making spectacle frames - they return to their original shape if they are put in hot water after bending



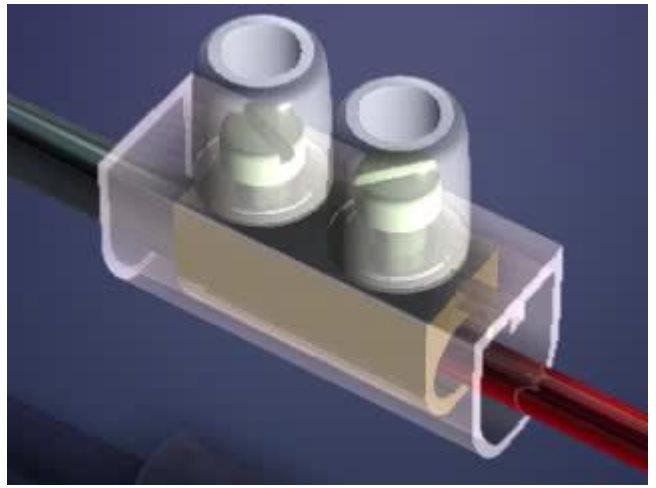
Uses: SMAs are used as triggers to start the sprinklers in fire alarm systems, controllers for hot water valves in showers or coffee machines and for spectacle frames. Brand names include **Nitino**l and **Memoflex**

A stent made from an S.M.A. Inserted into an artery it will expand to allow greater blood flow

Dental braces are made of Nitinol wire they exert a constant force on the teeth to return the teeth to their correct position

Smart Springs

- Made from any alloy of nickel/titanium
- Very similar to Shape Memory Alloys
- At room temperature the spring is fully extended manually
- By heating up or applying a small electric current the spring will return to its original position and carry a load

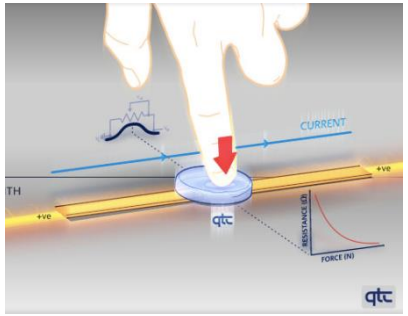


- Possible applications
  - Emergency shutter in case of fire of:
    - Bin lids
    - Blinds
    - windows

Quantum Tunnelling Composite

Quantum-tunnelling composite (QTC) is a **flexible polymer which contains tiny metal particles**. It is normally an insulator but if it is squeezed it becomes a conductor.
QTC can be used to make membrane switches like those used on mobile phones, pressure sensors and speed controllers.

An example of where QTC fabrics can be woven into clothing. The jacket sleeve features a control panel for the operation of a personal stereo

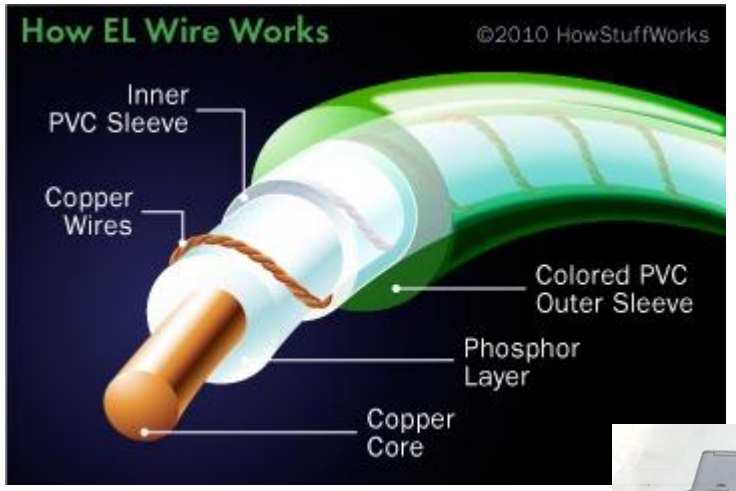


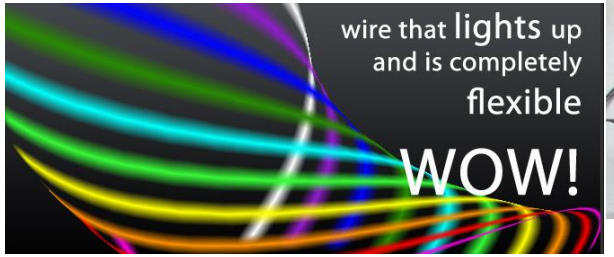
music greeting card and this smart material is used to create an electric current from movement

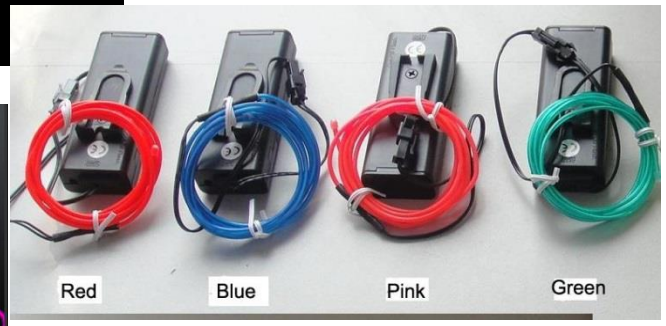
QTC is driving touch screen technology

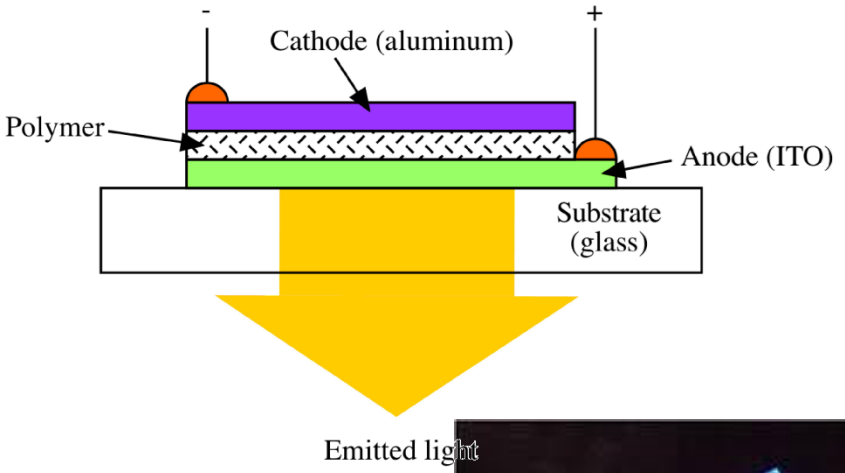
Electroluminescent wire

Electroluminescent wire (often abbreviated as **EL wire**) is a thin copper wire coated in a phosphor which glows when an alternating current is applied to it. It can be used in a wide variety of applications—vehicle and/or structure decoration, safety and emergency lighting, toys, clothing etc.—much as rope light or Christmas lights are often used. Unlike these types of strand lights, EL wire is not a series of points, but produces a 360 degree unbroken line of visible light. Its thin diameter makes it flexible and ideal for use in a variety of applications such as clothing or costumes

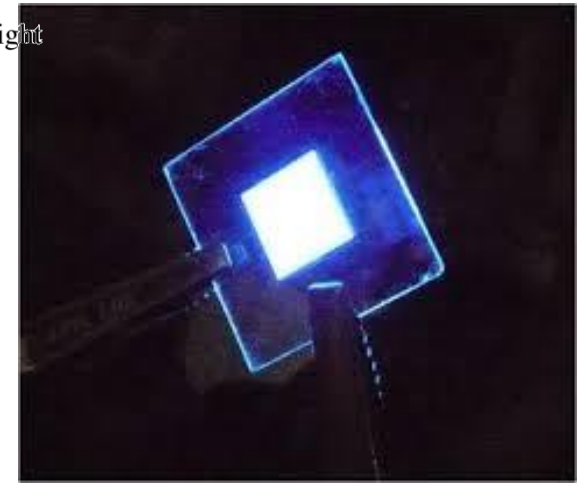








Polymer LED (light-emitting diode)
- sometimes called light-emitting polymer or poly LED - is a technology based on the use of polymer as the semiconductor material in LEDs.



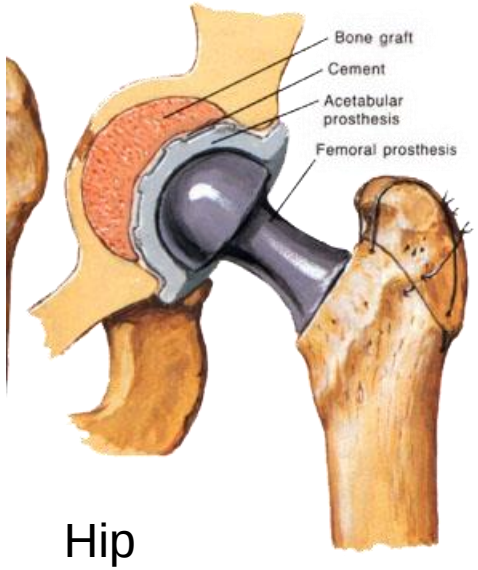
Polymer LEDs have a number of inherent qualities that are ideally suited to such applications: they enable full-spectrum color displays, high brightness at low drive voltages, glare-free viewing, and long operating lifetimes. It is currently possible to create a small text display by structuring the polymer material and electrodes. The technology also offers a great deal of promise as a basis for cheaper, simpler lighting sources.

Modern Materials

Modern Materials are those that generally have been discovered and used within the last century. They do not react to their environment like smart materials.

Titanium

The two most useful properties of the metal are corrosion resistance and the highest strength-to-density ratio of any metallic element. In its unalloyed condition, titanium is as strong as some steels, but less dense. Titanium can be alloyed with other elements, to produce strong, lightweight alloys for aerospace and spacecraft, medical prostheses, orthopaedic implants, dental and endodontic instruments and files, dental implants, sporting goods, jewellery, mobile phones, and other applications.



Hip replacement

Aircraft parts

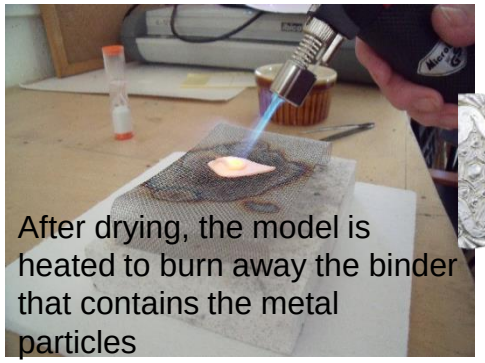
Some mobile phone casings

Precious metal clay

Metal clay is a crafting medium consisting of very small particles of metal such as silver, gold, bronze, or copper mixed with an organic binder and water for use in making jewellery, beads and small sculptures. Originating in Japan in 1990, metal clay can be shaped just like any soft clay, by hand or using moulds. After drying, the clay can be fired in a variety of ways such as in a kiln, with a handheld gas torch, or on a gas stove, depending on the type of clay and the metal in it. The binder burns away, leaving the pure sintered metal. **Shrinkage of between 8% and 30% occurs (depending on the product used)**. Alloys such as bronze, sterling silver, and steel also are available.

P.M.C can be purchased from craft suppliers.

Product is modelled in the clay



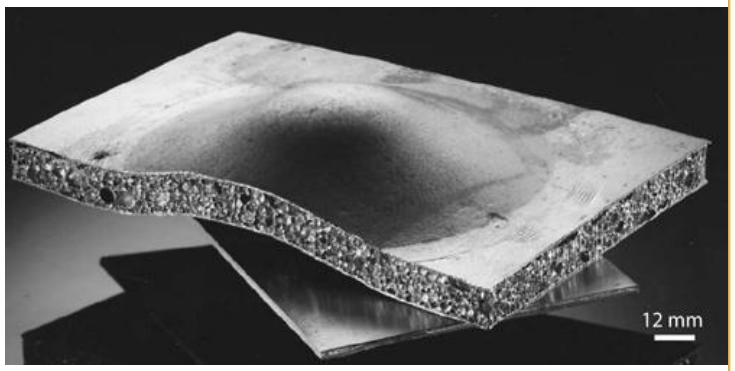
After drying, the model is heated to burn away the binder that contains the metal particles

The completed item

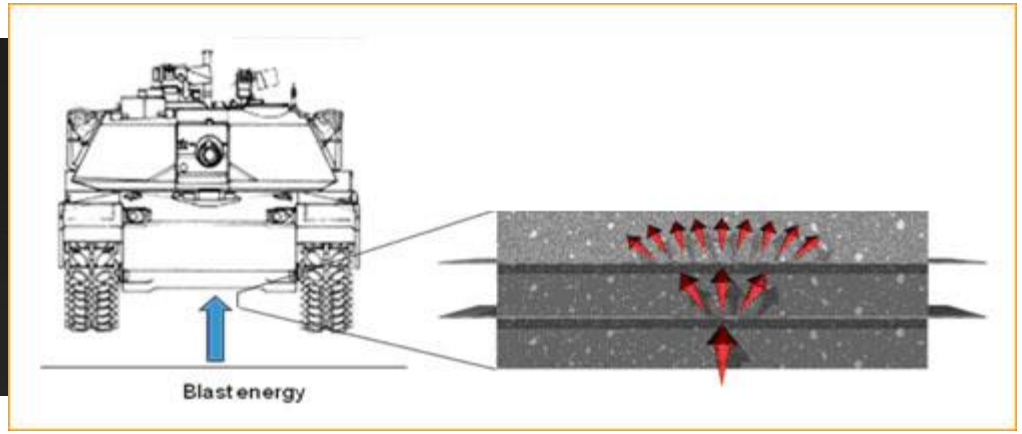
Pendant made with P.M.C

Metal Foams

A **metal foam** is a cellular structure consisting of a solid metal, frequently aluminium, as well as a large volume fraction of gas-filled pores. Typically, 75–95% of the volume consists of void spaces making these ultralight materials that retain many of the characteristics of their source metal



Metal foams make excellent strength to weight ratio components



Foams are used as part of some tank armour plating

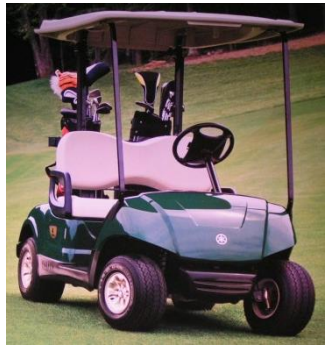
Foam chocolate

Glass reinforced plastic G.R.P

Fiberglass is a strong lightweight material and is used for many products. Although it is not as strong and stiff as composites based on carbon fibre, it is less brittle, and its raw materials are much cheaper. Its bulk strength and weight are also better than many metals, and it can be more readily moulded into complex shapes. Applications of fiberglass include aircraft, boats, automobiles, bath tubs and enclosures, swimming pools, hot tubs, septic tanks, water tanks, roofing, pipes, cladding, casts, surfboards, and external door skins. The fibreglass is coated and soaked in epoxy resin, polyester resin or vinylester or sometimes a thermoplastic

Custom or limited edition vehicle body construction

Marine construction



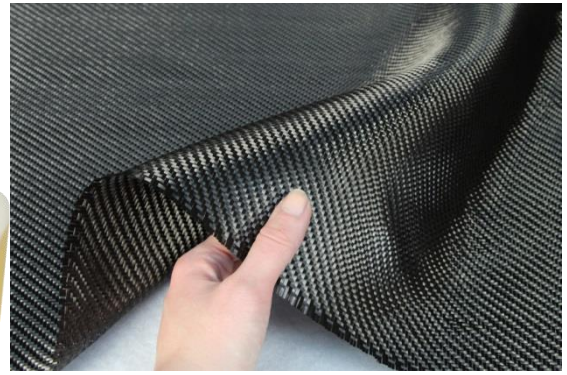
Custom, one off productions for fairgrounds and museums.

Carbon fibre

Carbon fibres are usually combined with other materials to form a composite. When combined with a plastic resin such as epoxy and wound or molded it forms a carbon-fibre-reinforced polymer (often referred to as carbon fibre**) which has a very high strength-to-weight ratio**, and is extremely rigid although somewhat brittle. The fibre glass weave is soaked in liquid plastic, and then pressed or heated until the material fuses together. The angle of the weave, as well as the resin used with the fibre, will determine the strength of the overall composite. The resin is most commonly epoxy, but can also be polystyrene. products made of carbon fibre include:

High-end automobile components
Bicycle frames
Fishing rods
Shoe soles
Baseball bats

Epoxy resin



Carbon fibre weave

Kevlar

Currently, Kevlar has many applications, ranging from bicycle tyres and racing sails to body armour because of its high tensile strength-to-weight ratio; by this measure it is 5 times stronger than steel. It is also used to make components that need to withstand high impact. When used as a woven material, it is suitable for mooring lines and other underwater applications.

A Kevlar weave

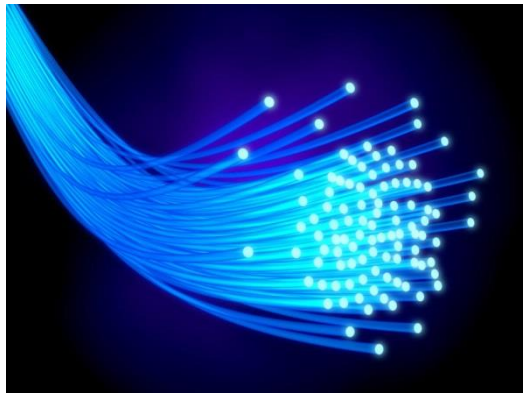
Body armour

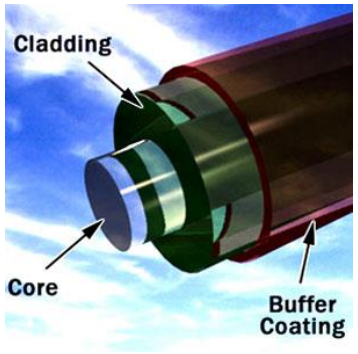
Car tyre with Kevlar weave inserts for strength

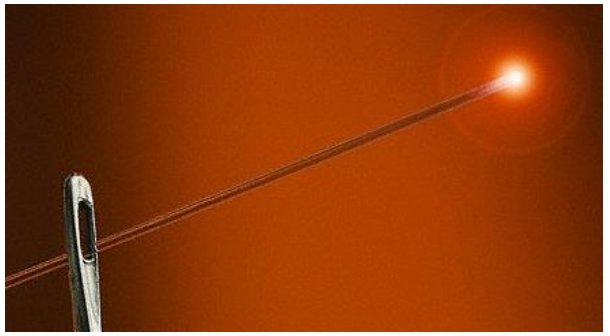
Canoe made with fibreglass and Kevlar composite construction.

Fibre Optics 1

You hear about fibre-optic cables whenever people talk about the telephone system, the cable TV system or the Internet. Fibre-optic lines are strands of optically pure **glass** as thin as a human hair that carry digital information over long distances. They are also used in medical imaging and mechanical engineering inspection. Electrical pulses are transmitted as light through the optic cables at a faster rate and over longer distances than traditional copper cable allows. This allows for greater bandwidth. The fibre optic cables do not carry electricity, they are smaller and cheaper to use. More advantages are shown on the next page.







Fibre Optics 2

The advantages of optical fibres over conventional copper wires are:

Less expensive - Several miles of optical cable can be made cheaper than equivalent lengths of copper wire.

Higher carrying capacity - Because optical fibres are thinner than copper wires, more fibres can be bundled into a given-diameter cable than copper wires. This allows more phone lines to go over the same cable or more channels to come through the cable into your cable TV box.

Less signal degradation - The loss of signal in optical fibre is less than in copper wire.

Light signals - Unlike electrical signals in copper wires, light signals from one fibre do not interfere with those of other fibres in the same cable. This means clearer phone conversations or TV reception.

Digital signals - Optical fibres are ideally suited for carrying digital information, which is especially useful in computer networks.

Non-flammable - Because no electricity is passed through optical fibres, there is no fire hazard.

Lightweight and thin - An optical cable weighs less than a comparable copper wire cable. Optical fibres can be drawn to smaller diameters than copper wire. Fibre-optic cables take up less space in the ground.

Phase Change Materials

Phase change materials (PCM) are substances that absorb and release thermal energy during the process of melting and freezing. When a PCM freezes, it releases a large amount of energy in the form of latent heat at a relatively constant temperature. These materials can absorb body heat, when the body cools, the material releases the heat keeping the user warm or cooling them if the process is in reverse

Warming blanket for a baby as it sleeps and its body cools

Cooling vest for athletes

Dichroic glass

Dichroic glass is glass which displays two different colours by undergoing a colour change in certain lighting conditions.
dichroic glassl is a modern composite non-translucent glass that is produced by stacking layers of glass and micro-layers of metals or oxides which give the glass shifting colours depending on the angle of view, causing an array of colours to be displayed. The resulting glass is used for decorative purposes such as stained glass and jewellery

Timbers and Manufactured Boards

A manufactured board is a timber product that has been altered or re arranged to give it superior physical and mechanical properties to ordinary, natural timbers.

Manufactured boards are much better at resisting distortion and deforming than natural timbers.

They don’t shrink and swell with changes in temperature and humidity, They are more stable and sometimes more durable.

They can be less wasteful than using natural timbers as all of the tree is used up.

Manufactured boards are made from timber veneers, strips, particles , fibres, or veneers

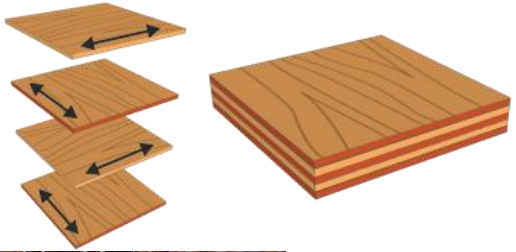
They are generally cheaper than natural timbers

Manufactured boards are available in thicknesses of 4mm, 6mm, 9mm, 12mm, 18mm, 22mm

Specialist boards and plywood’s such as Aeroply and Marine ply are very expensive and high quality engineering materials.

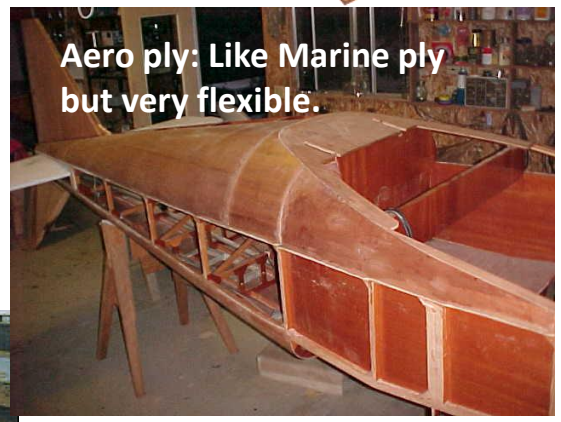
Plywood

Plywood is a sheet material manufactured from thin layers or "plies" of wood veneer that are glued together with adjacent layers having their wood grain rotated up to 90 degrees to one another.

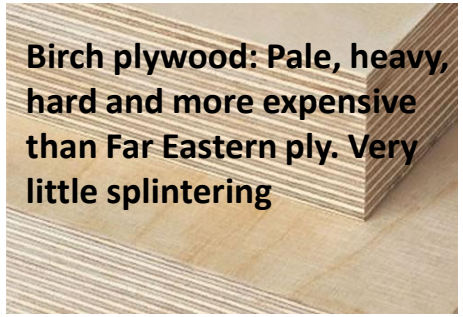


Far Eastern Plywood: Cheap, full of splinters and horrible

Marine plywood: Expensive and excellent resistance to humidity and water.



Aero ply: Like Marine ply but very flexible.



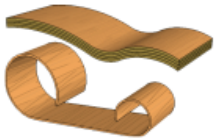
Birch plywood: Pale, heavy, hard and more expensive than Far Eastern ply. Very little splintering

De Havilland Mosquito: The worlds first all wood fighter bomber. Made almost entirely of Aero ply.

Birch plywood cabinet

Shuttering ply for concrete casting

MANMADE BOARDS - FLEXI PLY



A flexible form of plywood. Can be formed into various 'curved shapes.

Composed of several layers of thin plies. Flexi Ply is ideal for all applications which require bends and curves. This allows the flexi ply to be manipulated into curved shapes.

Available in a range of thicknesses.

Used in modern furniture and interior design, where curved surfaces are required.

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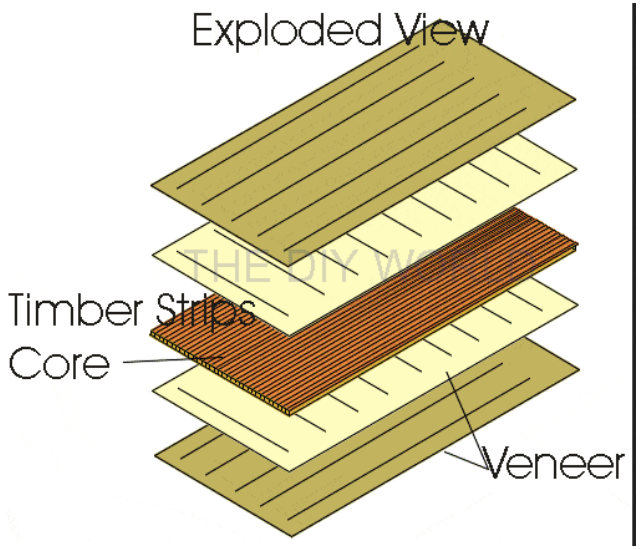
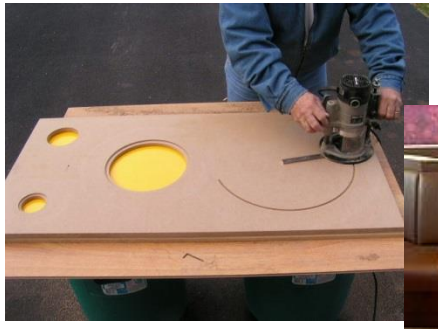
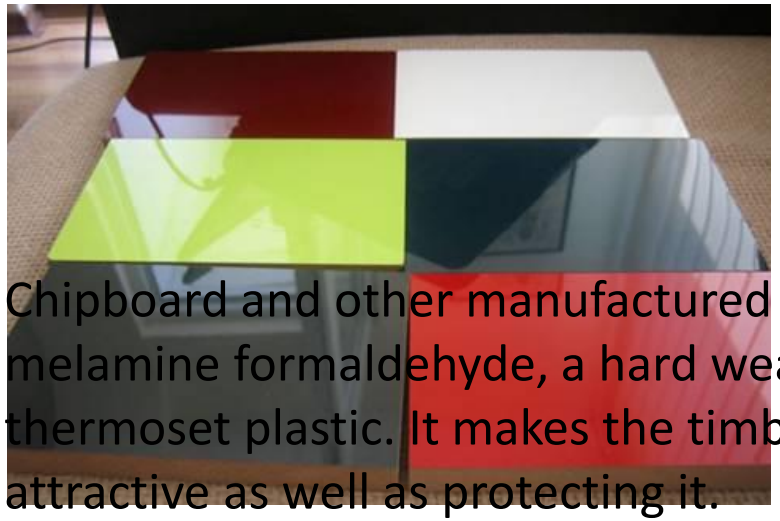
Block board and Lamin board. **Strips of timber bonded length ways and faced with plywood. Used for better quality work tops and shelving. Very good at resisting bending and bowing.**





<u>Medium Density Fibreboard</u>: Timber is broken down into super fine particles and bonded with formaldehyde to form a very heavy, hard, smooth , flat and straight sheet material. Concern remains about the health problems M.D.F. may cause. It takes painted finishes really well and is available as ‘flexible M.D.F’ for making curves and circles is also easy to machine and shapes well.

Chipboard: Small particles of timber are moulded into a flat sheet. Rough, heavy and flaky. Used for cheap work tops, flooring, wall linings and low cost cabinets when used with a veneer or laminate covering.



Chipboard and other manufactured boards can be faced with a layer of melamine formaldehyde, a hard wearing, heat and water resistant thermoset plastic. It makes the timber product look more expensive and attractive as well as protecting it.

Aeroply

Aeroply is ideal of producing curves and irregular shapes and forms. Layers of aeroply are glued together whilst being securely held on to a former/mould. This is typical of laminating.

Aeroply gives the opportunity to form unusually curved shapes that cannot be manufactured using any other material, to the same high standard. Aesthetically pleasing shapes can be the result.

Aeroply can be painted or stained. It can be glued with normal wood glues such as woodworkers resin / PVA.

Maplex

Is a next-generation building material made from 100% pressed wood fibres, with no binding agents. The lack of chemical binding agents makes the material completely biodegradable and recyclable. It is considered to be the safer and sustainable alternative to plywood and M.D.F. There are grades of Maplex that can be bent

Maplex furniture

Hexaboard is a high quality birch plywood coated with a UV resistant black phenolic grp film. The face surface is imprinted with a 10mm hexagonal pattern, the reverse has a smooth phenolic moisture barrier. It was originally adapted as flooring in the transport industry ie. trailers, horse boxes and commercial vehicles, also for building applications, such as warehouse floors, loading platforms and scaffolding, hence it’s hard wearing properties. Often used for high quality transport crates.

Nanomaterials

Nanomaterials occur in nature. The structure of foraminifera and viruses (capsid), the wax crystals covering a lotus or nasturtium leaf, spider and spider-mite silk, the "spatulae" on the bottom of gecko feet, some butterfly wing scales, natural colloids (milk, blood), horny materials (skin, claws, beaks, feathers, horns, hair), paper, cotton, nacre, corals, and even our own bone matrix are all natural organic nanomaterials.

Manufactured nanomaterials are those broadly defined as having tiny components Sometimes nanomaterials are used as thin films or surface coatings, as on computer chips or as nanowires, nanotubes, or as blobs of tiny nanocrystalline particles

Properties of manufactured nanomaterials vary but can include improvements such as:

magnetic/optical performance
electrical conductivity
strength/elasticity
thermal conductivity
Absorbency

This has resulted in the development of:

harder and tougher tools
water-repellent and anti-bacterial coatings
wear- and scratch-resistant hard coatings
UV absorbent and reflective transparent-looking nanosized titanium dioxide and zinc oxide in some sunscreens
a military battle suit that that will withstand blast waves.

Gecko feet use natural nanomaterial technology to help it stick to any surface

Nanomaterial finishes

Nanomaterial finishes	Characteristics	Uses
ZANO	UV-absorbers for fabrics: protects fabrics from degradation, protects against sunburn of wearer. ZANO is a fungistat.	Summer clothing Hammocks Tents Mountain wear Climbing wear Sportswear
NanoGrain CeO2	UV-absorbers for fabrics: protects fabrics from degradation, protects against sunburn of wearer.	Summer clothing Umbrellas Swimwear Tents
NanoGrain TiO_2 (rutile) or Optisol	Partial UV-absorbers for fabrics, protects fabrics from degradation, protects against sunburn of wearer.	Summer clothing Tents
NanoGrain TiO_2 (anatase)	Can combat malodours on textiles by stopping decomposition of food, sweat, etc.	Socks and underwear Shoe insoles Sportswear Children's clothing

Integrated electronics

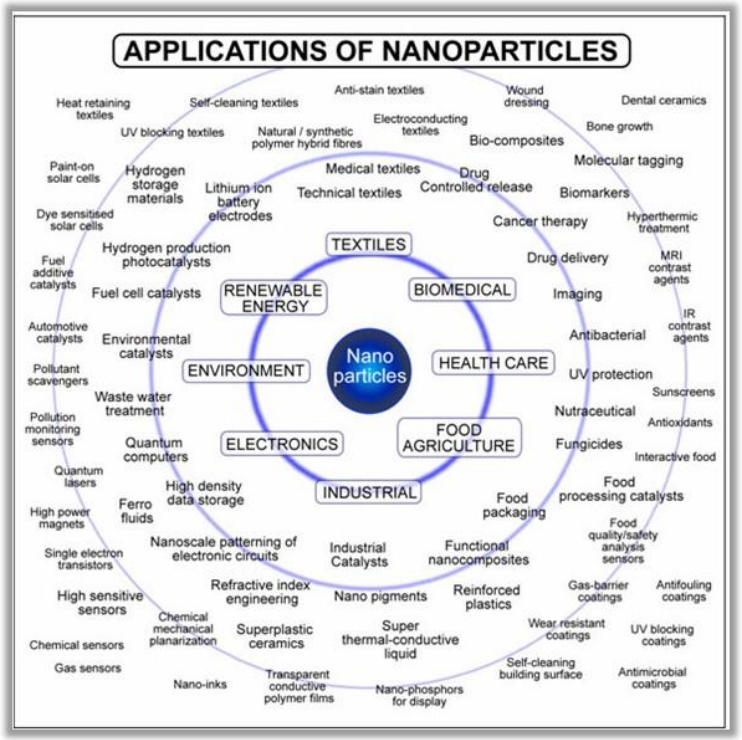
LEDs and other electronic components such as **sensors** are being integrated into textile and other products, and can offer a dual-purpose product like a wearable light-emitting garment or a roll-up illuminated mat.

Why are nanomaterials important

- These materials have created a high interest in recent years by their high **mechanical**, **electrical**, **optical** and **magnetic** properties.

Applications of nanomaterials

- nanophase ceramics
- nanostructured semiconductors
- Nanosized metallic powders
- Single nanosized magnetic particles
- Nanostructured metal-oxide thin films



Smart and Modern Materials

1) Name and describe a use for a thermo chromic pigment

2) Name and describe a use for a photochromic ink or material. How does a photochromic material differ from a thermo chromic material?

3) Suggest a use for electro chromic glass. Describe two advantages of smart glass in an office building.

4) Briefly describe how electro rheostatic and magneto rheostatic materials work. Suggest two uses for either.

5) Describe how Polymorph can be formed and suggest two suitable uses for it

6) Briefly describe what a piezo-electric material is. Suggest two uses for a piezo electric material

7) Suggest two uses for a shape memory alloy

8) Describe two uses for a smart spring. How does a smart spring differ from a shape memory alloy?

9) Suggest a use for a Quantum Tunnelling Composite

10) Describe two uses for an electro luminescent wire.

11) Describe a use for a light emitting polymer. Mention its advantage for flexible flat panel display. Could you imagine a garment capable of displaying an image or text like a computer screen?

Modern Materials

1) Briefly describe the difference between a smart material and a modern material

2) Describe the advantage of titanium over steel.

3) Describe an advantage of using a precious metal clay over normal metal casting

4) Briefly describe how a metal foam is formed. Describe an advantage of metal foams over solid material. Can you think of a cellular structure in your body.

5) Briefly describe how glass reinforced plastic products are produced. Is it a suitable process for mass production? Give reasons.

6) What two thermosets can be used for G.R.P or carbon fibre building?

7) Describe advantages of carbon fibre over other construction materials. Suggest two uses for carbon fibre.

8) Suggest two uses for Kevlar

9) Describe two advantages of fibre optic cables over copper wire as a method of data transfer.

10) Suggest two uses for a phase change materials

11) Describe what a nano material is. Describe two uses for nano materials that exist at present. Describe two posisible uses in the future for a nano material.