Exemplar Materials: Unit 11 Materials for a Purpose

EXEMPLAR PORTFOLIO WORK – ASSIGNMENT 11

Materials for a Purpose

(**NB** This portfolio is intended as an example of a typical students' work rather than a perfect model. As such it contains errors in punctuation, spelling, grammar as well as occasional incorrect use of words).

A poster and accompanying leaflet outlining the structures of polymers, metals, ceramics or glasses, and composite materials.

Poster is produced by enlarging each of the A4 sheets to A3, then placing side by side to form an A2 poster.

Leaflet could be produced by printing two A4 sheets back-to-back and folding in half vertically.

COMMENTARY ON MARK ALLOCATION

(The assignment scores 5 marks out of a possible 10)

Task 1

General comments:

<u>Poster</u> It had been envisaged that the poster would have been designed with more illustrations and the text less dense. However presentation is not included in the mark allocation.

<u>Leaflet</u> It would normally be expected that the leaflet would include additional detail, for example supporting data/or be a worksheet. The lack of additional detail (except for the data table on composites is reflected in the mark allocation.

This is an adequate piece of work easily covering the minimum requirements of the brief but lacking the kind of detail that would have been found given more thorough research. No information about sources is given.

AO1a

The candidate has produced descriptions with diagrams of the structures of two polymers and two metals. Mark Band 2 is therefore achieved. 3 marks scored.

Mark Band 3 is not achieved because this would require more than two examples. Had a third example been given for each type of material, 1 further mark would have been scored. Some information is given, relating the structures to physical properties. To achieve full marks would have required further amplification in the leaflet.

AO1b

The candidate has produced descriptions with diagrams of the structures of two ceramics and of the structures of two composites without diagrams. Mark Band 2 is therefore partially achieved. 2 marks scored.

The third mark has not been scored because diagrams of composite structures are omitted and one of the composites, concrete is not appropriate for the brief.

Mark Band 3 is not achieved. This would require more than two examples and further amplification in the leaflet. The amplification of the criteria makes it clear that to achieve MB3, the student must ’demonstrate that they can relate the differences in the properties of the different classes of materials listed to their structures.’ This could be achieved by a much more extensive leaflet without the need for a worksheet and questions in task 3. Their inclusion makes it more likely that students aiming for this level will be prompted to go into sufficient depth.

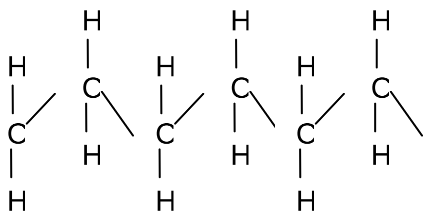
Polymers.

Made up of repeated units that come from small molecules called monomers the polymer was made from.

Structure

- Linear

e.g. Polyethylene

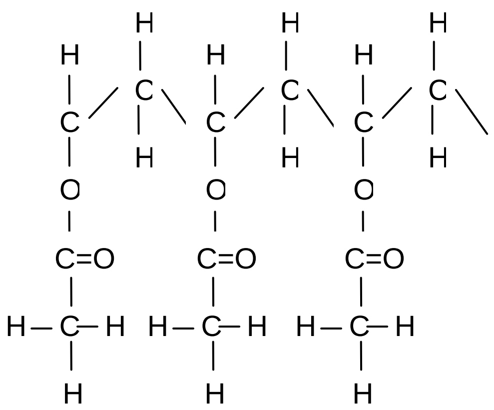


High Density Polyethylene (HDPE) has long chains like in the diagram above. It is made using complex catalysts at low temperatures (350 K). Because it has few side chains the chains pack together closely and it has 75 – 95% crystallinity. It therefore has greater strength and stiffness than Low density Polyethylene (LDPE) which is made using simple catalysts at higher temperatures and has only 55 -70 % crystallinity.

HDPE used for large containers and crates because stiffer. It softens at 120-130 ^{o} C.
LDPE used for film and sheeting. It softens at 120-130 ^{o} C. Transparent.

- Branched

e.g. Poly(vinyl acetate)



Side chains make it very soft. No use as a moulding material on its own. Used as adhesive and as substitute for starch. Combined with rigid PVC to make floor coverings.

- Cross-linked

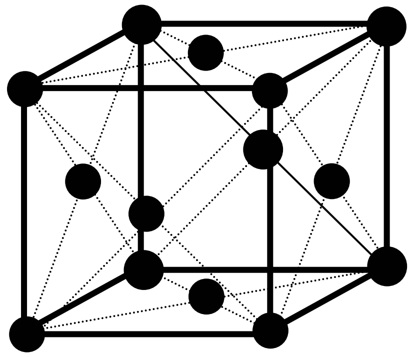
Metals

Copper.

Used since the bonze age. Bronze is an allow of copper and tin.

Structure

Pure copper is Face Centred Cubic in structure. i.e. the repeating cells of a crystal are cubes with an atom at each corner and an extra atom at the centre of each face



Properties

- Cheaper than Silver
- becomes soft at 700 K
- High electrical conductivity
- High thermal conductivity
- Very ductile because FCC
- Tensile strength < 215 x 10^{6} N m^{-2}

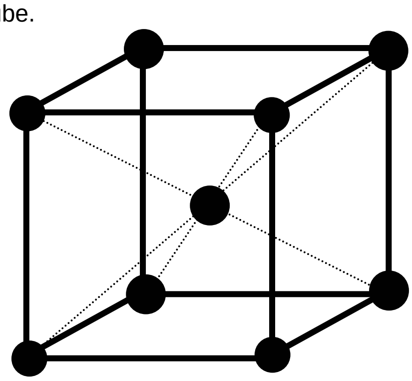
Uses

Electrical wiring. Add cadmium to increase strength for Telephone wires.

Iron

Structure

Iron up to 910 ^{o}C is Body Centred Cubic in structure. i.e. the repeating cells of acrystal are cubes with an atom at each corner and an extra atom at the centre of the cube.



Pure iron has little practical value. Add carbon to make the alloy steel. The extra carbon atom is an interstitial (extra atom between existing ones).

Properties

- mild steel becomes soft at 900 K

Uses

Steel is a very important engineering material

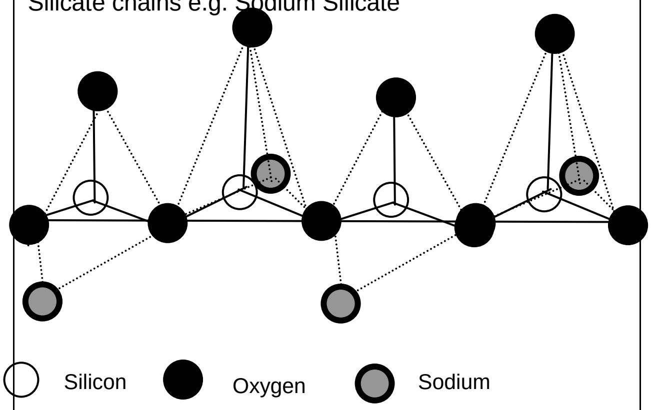
Ceramics

Ceramics are substances with a Structure similar to that of fired earthenware or china. (rocks, minerals, glass, porcelain, asbestos)

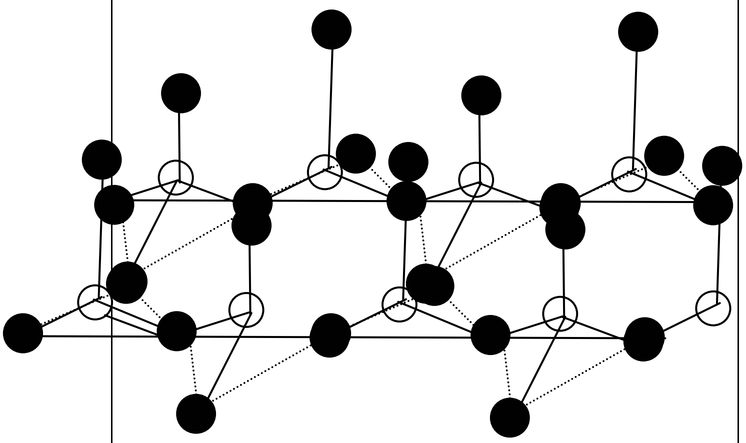
Structure

Covalent bonds therefore tend to be very rigid compared to metals

Silicate chains e.g. Sodium Silicate



Silicate sheets e.g. Mica



Properties

Good thermal and electrical insulators

High bond strength therefore heart a chemically resistant

Less ductile than metals.

Sheet materials such as mica cleave easily.

Composite Materials

Mixtures of two or more different materials bonded together. The combination of materials has better properties than the parts on their own.

Example 1

Glass Fibre Reinforced plastic (GFPR).

Very thin glass fibres (10^{-7} m diameter) embedded in thermoset plastic (usually epoxy resin or polyester). Thermosets are not very stiff or tough. Glass is stiff and strong in compression but breaks easily. When combined, the glass fibres stiffen and toughen the plastic. the plastic protects the fibres.

If the fibres all run parallel to each other the material has good tensile strength in the direction of the fibres, but is weak at right angles to this direction

If the fibres are arranged randomly the material has the same strength in all directions.

Fibres are also commonly used woven mats.

Uses

Car bodies. Half the mass of steel - saves on fuel.

Yacht hulls.

aircraft & train nose cones

Example 2

Concrete

Cement and "dense aggregates" (gravel). Cement is brittle and cracks easily. Adding gravel increases the Young modulus. The stress strain curve is steeper. The gravel strengthens and toughens the cement. The cement holds the sand and gravel together. Gravel is cheaper than cement.

Reinforced concrete also has metal steel rods. Concrete is weak in tension but steel is strong in tension.

Uses:

Concrete beams, bridges.

Data

Toughness G_c = energy absorbed in creating unit area of crack.

material	Toughness G_c /kJ m^{-2}
polyester	0.1
epoxy	0.3
GFRP random fibres	40
GFPR along aligned fibres	100
Glass	0.001 – 0.01
mild steel	100
cement	0.01 – 0.03
reinforced concrete	up to 4

Task 2

In addition, the work can be supported by a worksheet devised by the student for use by the company for educational visits.

This will also show how much the students have understood the work they have researched.

For MB3, students need to complete a mark scheme and include questions on the worksheet to show how structures relate to physical properties.

Example of worksheet if Task 2 included in assignment:

WHAT DO YOU KNOW ABOUT STRUCTURE?

Worksheet 1

Ceramics

(i) Give an example of a ceramic that is made by the Company?

(ii) What type of bonds are found in this type of material?

(iii) Name a property that this material has.

(iv) Give an example of what this material is used for.

(v) Could it be used in the car of tomorrow?

(vi) If you give the answer YES, explain what it could be used for and why.

Find out more information about ceramics on your tour.