

Ceramics and Composites Notes

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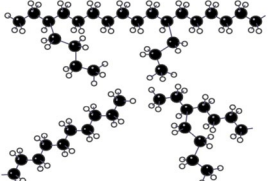
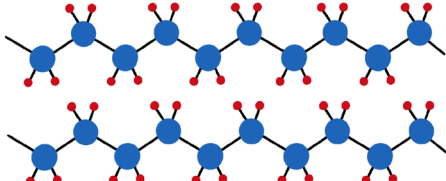
The properties of a material, its boiling, melting point and whether or not it conducts electricity are all determined by the structure and bonding of the material. In just the same way polymers have different properties depending on what monomers make up the polymer. Let's quickly remind ourselves what those terms mean.

A polymer: a long chain molecule made by joining many smaller molecules called monomers together.

A monomer: a small molecule that can join with other molecules like itself to form a polymer.

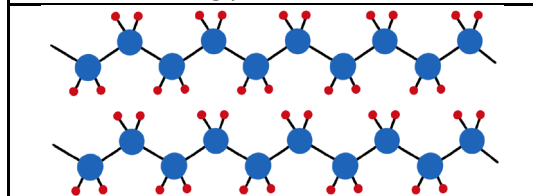
Low density poly(ethene) & High density poly(ethene)

For the GCSE we must be able to distinguish between low density and high density ethene and give their uses.

Low density poly(ethene)	High density poly(ethene)
	
What is it? It's a polymer that has branches that are quite far apart.	What is it? It's a polymer that has branches that are packed quite close together.
Uses: it is used in most carrier bags & bubble wrap.	Uses: used in many plastic bottles, buckets & pipes.
How are they made?	
How is LDPE made? Using very high pressure and a trace of oxygen.	
How is HDPE made? Using a catalyst at a lower temperature and pressure.	
Note: there are no double bonds in the polymer, all of these are broken during the reaction.	
<u>Which type of polymer is made depends on the reaction conditions and the type of catalyst used.</u>	
High density poly(ethene) has a higher crystallinity and a higher melting point than low density poly(ethene). High density poly(ethene) is stronger and stiffer than low density poly(ethene).	
Crystallinity: <u>the measure of the structural order in a solid.</u> In a crystal, the atoms or molecules are arranged in a regular, ordered manner.	

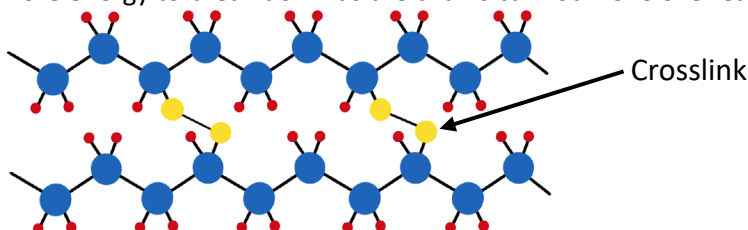
Thermosoftening and Thermosetting Polymers

Thermosoftening polymers: melt when they are heated. Most plastics that we come across in everyday life are thermosoftening plastics. This means that they can be recycled.



Thermosoftening plastics do not have covalent bonds (cross links) between neighbouring polymer molecules, so the molecules can move over each other when heated and the plastic melts.

Thermosetting plastics: do not melt when heated. Thermosetting polymers have crosslinks between the polymer chains. They therefore require far more energy to break down as the chains cannot move over each other easily.



Ceramics

We are also required to know a few other materials for the exams.

Ceramic: a hard, durable, non-metallic material which is generally unaffected by heat, e.g. glass and china. There are two categories of ceramic, **clay and glass**.

Bricks, porcelain and china are clay ceramics. They are all made from clay, which is shaped and then heated to a very high temperature.

Glass ceramics are made by melting sand and letting it cool and form a solid. Glass has crystals so glass is transparent.

Metals

Metals: most are strong, hard, shiny solids with high melting points. They are good conductors of heat and electricity. They are ductile and malleable.

Metallic Compounds

Structure:	The structure of metal is known as a <u>giant lattice</u> .
Does it conduct electricity?	Yes.
How do metals conduct electricity?	<u>The electrons are free to move throughout the metal. This is why all metals conduct electricity.</u>
Melting and boiling point:	Metallic bonding is quite strong, so metals are all solids at room temperature (except mercury) and generally have high melting points. The strong bonds make metals strong materials.

Metals are often called malleable and ductile. But what do these terms mean?

Malleable: means it can be hammered into shape.

Ductile: means it can be drawn out into wire shape.

Alloys

An alloy is a mixture of two or more elements, where at least one element is a metal. Many alloys are mixtures of two or more metals.



Alloys are usually harder and stronger than the pure metals they contain.

This is because the different sized atoms make it harder for the layers of atoms to slide over each other. Alloys are useful because they allow the best properties of metals to be combined. Steel is an alloy, it is a mixture of iron and carbon, (mostly iron though).

Composite Materials

Composite material: a mixture of two or more materials which are combined to produce a material with better qualities. For example, reinforced concrete.

Most composite materials have two components:

1. **The reinforcement** – this gives the material its strength.
2. **The matrix** – this gives the material some flexibility and reduces its brittleness.

An example of a composite material is fibreglass. This is made of a combination of thin glass fibres which provide reinforcement, as they have a high tensile strength, and a polymer resin which forms the matrix around these glass fibres. Whilst the glass fibres provide high tensile strength, they are unfortunately brittle and could easily break.

The polymer resin around the glass fibres provides a measure of flexibility and is hard wearing which counteracts the brittleness of the glass fibres. Fibreglass, as a composite material, has positive properties from both components; it is strong yet light weight and tough.