

Changing properties

SECTION 1.1

Changing properties

Alloying is a common way to change the material properties of a product, this can make the alloy more tough, corrosion resistant or higher in strength. This can be achieved by melting the two or more metals together so they become chemically fixed

Other ways properties can be changed is to:

- modify the structure of the metal
- Change the surface chemistry

Modifying the structure of metals

Under a microscope metals are made up of lots of grains of material that are pressed together. The size and shape of the grain affects the mechanical properties of the metal. If the grain is short then the material will be hard and strong but not very ductile and more brittle.

The grain size can be affected by cold working which will shorten the grain or heat treatments which will increase the length of the grain.

Cold working

As metals are worked they get harder and this is called **Work Hardening**. This can cause metals to get brittle and break when being worked. This occurs because the grain structure are deformed and become stretched out and thinner and smaller in that direction. Further within the grain tiny flaws exist in how the atoms are arranged, repeated working causes the atoms to pin each other in place stopping movement of the atoms reducing ductility and increasing brittleness.

Heat treatments

Hardening / Quenching

This is completed on High Carbon Steels and is completed by heating the steel and then quenching it in cold water. It can then be tempered which results in the Steel having Hardness and Toughness combined.

Normalising

This process is carried out on Steel that has been work hardened and results in the Steel being tough with some ductility removing the brittleness caused by work hardening.

Corrosion

Corrosion is where the surface of the metal reacts with another substance in its environment i.e. aluminium reacting with oxygen to form aluminium oxide or low carbon steel reacting with water to form rust.

A layer of oxidation can act as protection to the metal below and the oxide is usually so thin you cannot see it.

However, corrosion on steel is progressive and will eat away the material over time affecting its visual appeal and strength as over time less and less steel is available to resist force.

Corrosion can be prevented by painting the steel, applying a plastic coating, applying a thin layer of metal (zinc).

Materials that corrode are often cheaper than those materials that don't corrode and this can be the reason why they are selected.

Carburising

Some products need to be hard and tough such as the gears on a train which need to be tough so they don't fracture and hard so they don't wear away. This is achieved by using low carbon steel which is naturally tough and then adding more carbon on the surface areas making this area hard. This process is called case hardening.

This process of case hardening is completed via two steps: Carburising and hardening

Carburising is completed by heating a piece of steel to a cherry red and then dipping it into a carbon powder, the carbon will then soak into the steel, this is then repeated two or three times more. This process can also be done in a furnace with carbon granules with the whole thing heated and left to soak at that temperature or by using a furnace and a controlled atmosphere filled with a carbon rich gas which will soak into the steel over several hours. This method is the most accurate in terms of percentage soak.

The hardening part is done by heating the carbon soaked steel to a cherry red and then quenching it making the outer edges hard.

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Changing the properties

Why would you want to change the properties of the metal?

What two ways could be used to change the properties of metal?

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- .

Modifying the structure of metal

Explain the structure of metals

What can affect these structures

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- .

What term is used when you work a piece of metal cold and what effect does this have on the metal?

Explain the term Annealing and how it is done.

Using the book pages and Internet, Explain the term Hardening

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Using the book pages or internet, Explain the term Tempering

Using the book pages or internet explain the term Normalising

Changing the surface chemistry

What is meant by the term corrosion?

Is Corrosion always a bad thing?

Why?

How can corrosion be prevented?

What is meant by the term case hardening?

How is Case Hardening achieved?
