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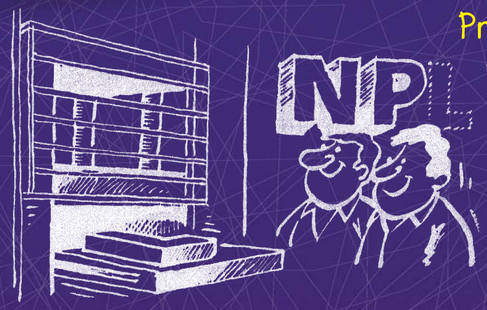
Materials

Materials are used everyday, in every society, ranging from the simple, such as wood and stone for basic dwellings, to futuristic alloys in spacecraft and satellites. With such a wealth of materials available it is important to select the right type for the job. We need to know if it will be strong enough, how long it will last or how well it insulates. These are just a few of the properties we need to be able to measure reliably to make a successful choice.



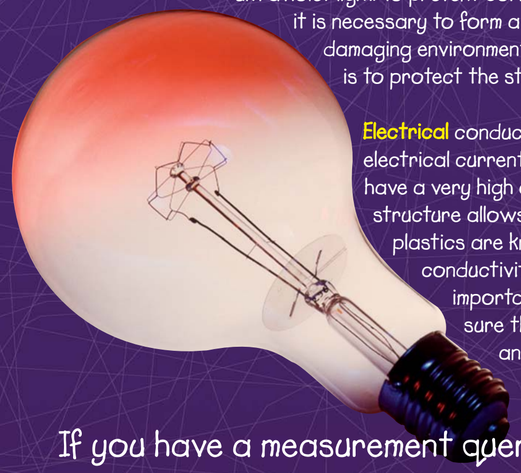
Properties of Materials

Why can you see through glass but not through paper? Why is gold heavier than silver? Why does wood burn but plastic melt? It is all down to the material's properties, which determine everything from melting point to hardness.

Chemical Properties

How a material reacts at an atomic or molecular level can have significant effect on its overall properties.

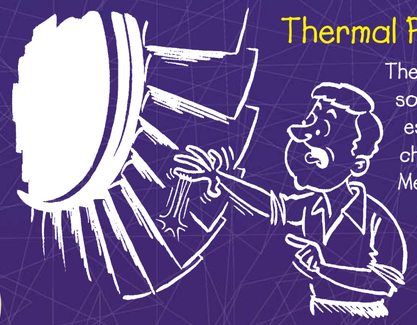
Corrosion is the gradual deterioration of a material due to its environment. In the presence of water and air iron will oxidise and form rust (iron oxide). This has none of the strength or hardness of iron. Non-metals can also corrode; plastics can become brittle and prone to cracking if exposed to organic fluids or ultraviolet light. To prevent corrosion it is necessary to form a barrier between the material and the damaging environment. One of the reasons we paint our cars is to protect the steel body panels from rusting.



Electrical conductivity is a measure of how easily an electrical current can flow through a material. Metals have a very high conductivity because the atomic structure allows electrons to flow freely. Ceramics and plastics are known as insulators, and have very low conductivity. When dealing with electricity it is important to insulate wires and cables to make sure the electricity goes where it is intended, and does not short-circuit.

Flow

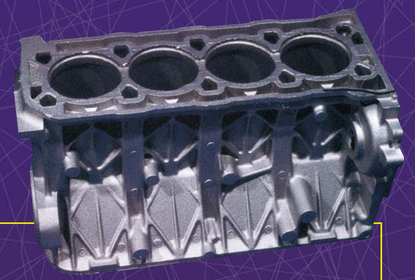
Viscosity is the resistance of a material to flow, or pour. Castor oil is more viscous than lemonade, it is thicker, and pours more slowly. Viscosity tends to change with temperature, as you heat honey it becomes runnier and easier to pour. Many manufacturing processes rely on the flow of materials, from chocolate to metal, so being able to measure viscosity is important.



Thermal Properties

The melting point of a material is the temperature at which a solid turns to a liquid. Knowing this property of a material is essential in many industries. The properties of all materials change to some extent depending on the temperature. Measuring these changes is vital in selecting the right material for the job. Making a teapot from a material that melts below 100 °C could be very dangerous, not to mention messy!

Thermal expansion is the tendency of a material to change in volume in response to a change in temperature. The Sydney harbour bridge can grow up to 18 cm taller in hot weather.



Mechanical Properties

The mechanical properties of a material tell us how it will perform in response to applied forces like stretching, bending or hitting.

The **hardness** of a material is its resistance to being permanently deformed or bent. We measure hardness by applying a known pressure, using an indenter, and seeing how far it will penetrate.

The **stiffness** of a material is a measure of how much force is needed to bend or stretch it. The ratio of the stress (force applied per unit of cross-sectional area) to strain (fractional change in length) is known as Young's Modulus, which can be used to predict how much load a wall can hold, or how much weight a cable can lift.

The **strength** of a material is gauged by how much stress it can take before it breaks. This could be compressive stress, where the material is squeezed, tensile stress, where the material is pulled or shear stress, where the material is twisted. Materials can be strong in one direction, but weak in another.

The **density** of a material is the mass per unit volume. The most dense material on earth is iridium, 1 cm^3 of iridium weighs over eight times as much as 1 cm^3 of aluminium. Low-density materials with high strength, such as titanium, are used in the aerospace industry to build aeroplanes that are lightweight but strong.

Time Line

4000 BC
Ancient Egyptians start using iron for spear tips, due to its strength.

100 BC
Romans invent concrete, a mouldable material with high compressive strength.

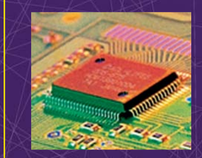
50 BC
Glass is used for vases and bottles. It is attractive, strong and water tight.

1830s
Charles Goodyear invents vulcanised rubber which retains its elasticity whatever the weather.

1850s
Henry Bessemer becomes the first person to mass-produce steel; it is very hard with great tensile strength and can be made into many different shapes.

1880s
The use of aluminium becomes widespread. Aluminium is very strong, yet light, and doesn't rust or corrode easily.

1930s
The first industrial production of polythene. Polythene is easy to make, light, impervious to water, provides both thermal and electrical insulation and is resistant to many chemicals.



1950s
Silicon's semiconductor properties make it increasingly useful in electronics and other high-tech applications.

1990s
Titanium, the "Miracle Metal", is light, strong and resistant to corrosion. Its extraordinary properties make it invaluable in a wide range of industries, from spacecraft to replacement hips.

If you have a measurement query contact us on: telephone: 020 8943 6880 e-mail: enquiry@npl.co.uk or visit: www.npl.co.uk

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