

Engineering Materials and their Characteristics p.1

| Ferrous Metals - contain iron | |
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| Metal type | Metal uses |
| Mild steel - A ductile and malleable metal. Mild steel will rust quickly it is in frequent contact with water. Properties – iron mixed with 0.15-0.29% carbon. | Used as Nuts and bolts, Building girders, car, bodies, gates, etc. |
| Cast iron - Is a very strong when it is in compression and is also very brittle. Properties – It is re-melted pig iron with small quantities of other metals. It consists of 93% iron and 4% carbon plus other elements. | Used as car Brake discs, car cylinders, metalwork vices, manhole covers, machinery bases eg: The pillar drill. |
| High carbon steel / Tool steel - Is a very strong and very hard, resistant to abrasion. It is also known as 'high carbon' steel or 'medium' steel. Properties – Up to 1.5% carbon content. | Used for hand tools such as screwdrivers, hammers, chisels, saws, spring and garden tools. |
| Stainless steel - is very resistant to ware and water corrosion and rust. Properties – It is an alloy of iron with a typical 18% chromium 8% nickel and 8% magnesium content. | Used for kitchen sinks, cutlery, teapots, cookware and surgical instruments. |
| High speed steel - is a metal containing a high content of tungsten, chromium and vanadium. However it is very brittle but is also very resistant to wear. | Used for drill bits, lathe tools, milling cutters on milling machines. It is used where high speeds and high temperatures are created. |

| Non - Ferrous metals and alloys (don't contain iron) | |
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| Metal type | Metal uses |
| Aluminium - tends to be light in colour although it can be polished to a mirror like appearance. It is very light in weight. | Used for saucepans. cooking foil, window frames, ladders, expensive bicycles. |
| Copper – is a ductile and malleable metal. It is often red / brown in colour. It is a very good conductor of heat and electricity. | Used for plumbing, electric components, cookware and roof coverings. |
| Tin – Is very ductile and very malleable. It is resistant to corrosion from moisture. It is bright silver in appearance. Tinplate is steel with a tin coating. | Used as a coating on food cans, beer cans. Used as whistles, tin foil and soldering. |
| Zinc – is very resistant to corrosion from moisture. However zinc is a very weak material. | Used as a coating on screws, steel buckets, American cents. It is also used to galvanise steel. |
| Brass – Is often cast and machined then plated. It is yellow in colour and is a mixture of 65% copper and 35% zinc. | It is used for decorative metal work such as door handles, candle sticks, musical instruments, ornaments. |

| Thermoplastics - softened and moulded with heat | |
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| Common Name | Properties |
| Polystyrene (high impact polystyrene) | Not tough. Comes in a wide range of colours. Thermoplastic |
| Acrylic (Polymethyl methacrylate) | Stiff, hard glass clear. Very durable outdoors. Easily machined, cemented and polished. Good electrical insulator. Safe with food. Ten times more impact resistance than glass. Splinters easily. Scratches easily. |
| Polypropylene | Resistant to chemicals. Flexible and very tough. Difficult to break. Relatively high melting point |

| Thermosetting plastics | Thermosetting plastic Properties |
|----------------------------------|---|
| Epoxy resin (Epoxide, ER) | Good electrical insulator, hard, brittle unless reinforced, resists chemicals well. |
| Polyester resin (PR) | Stiff, hard, brittle unless laminated, good electrical insulator, resists chemicals well. |

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Composites = Materials that are combined with others to make new, often stronger, stiffer and lighter materials

| Name | Appearance | Characteristics | Uses |
|---------------------------------------|--|--|--|
| Glass Reinforced Plastic (GRP) | Glass fibre matting covered in a smooth resin with a glossy finish. Can be coloured, complex shapes can be formed. | Lightweight, strong, resistant to heat, chemicals and corrosion. Waterproof. Labour intensive to produce. | Car body parts, pipes, helmets, boat hulls. |
| Carbon Fibre Reinforced Plastic (CRP) | Carbon in the form of graphite is soft. But very thin strands of carbon are very stiff. These carbon fibres are useful for reinforcing other materials to make them tougher. They are embedded in strong plastics to make composite materials. | Lightweight, strong, good tensile strength, rigid, very expensive resistant to heat, chemicals and corrosion. Waterproof. Labour intensive to produce. | Skateboards, boat hulls and high performance sports equipment. |

| Hardwoods | |
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| Hardwood types | Hardwood uses |
| Oak - A very strong wood which is light in colour. Open grain. Hard to work with. When treated it looks very classy and elegant. A hardwood. | Used for high class furniture, boats, beams used in buildings, veneers. |
| Balsa - is a pale white to gray. It has a distinct velvety feel. It has exceptional strength to weight properties. It is the lightest and softest wood on the market. A hardwood. | Used for light work such as model making and model airplane construction. |

| Manufactured Boards |
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| MDF - Smooth, even surface. Easily machined and painted or stained. Also available in water and fire resistant forms. A manufactured board. |
| Plywood - A very strong board which is constructed of layers of veneer or piles which are glued at 90 degrees to each other. Interior and exterior grades are available. A manufactured board. |
| Chipboard - Made from chips of wood glued together. Usually veneered or covered in plastic laminate. A manufactured board. |

| Softwoods | |
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| Softwood types | Softwood uses |
| Scots pine - A straight-grained softwood but knotty. Light in colour. Fairly strong but easy to work with. Cheap and readily available. A softwood. | Used for DIY and cheap quality furniture. Mainly used for constructional work and simple joinery. |
| Spruce - Creamy-white softwood with small hard knots. Not very durable. A softwood. | Used for general indoor work, whitewood furniture used in bedrooms and kitchens. |
| Cedar - A pale yellow-coloured softwood with a fine even texture. Light in weight but stiff and stable. | Used for furniture, boat building, veneers, and model making. |

Properties of Engineering Materials

Chemical

- Heat of combustion - The amount of heat released when one mol of a material is burnt
- Toxicity - The degree to which a substance can harm humans or animals
- Oxidation state - The degree of electron loss (oxidation) of an atom in a chemical compound

Electrical and magnetic

- Conductivity - The ability of a material to allow electricity to flow through it
- Resistance - The ability of a material to prevent electricity from flowing through it.
- Magnetism - a force that can attract (pull closer) or repel (push away) objects that have a magnetic material like iron inside them

Mechanical

- Strength - The ability of a material to withstand a force without breaking (tensile or compressive)
- Hardness - The ability of a material to withstand scratching and indentation.
- Toughness - The ability of a material to withstand impacts without breaking
- Elasticity - The ability of a material to return to its original shape after an applied load has been removed
- Plasticity - The ability of a material to be easily shaped and moulded
- Ductility - The ability of a material to be stretched (drawn) out.
- Durability - The ability of a material to withstand wear, pressure or damage
- Malleability - The ability of a material to be hammered and pressed without breaking

Optical

- Reflectivity - The amount of light reflected by a material
- Photosensitivity - The amount to which a material reacts to receiving visible light

Thermal

- Flammability - The ability of a material to burn or ignite
- Thermal conductivity - The ability of a material to allow heat to flow through it
- Melting point - The temperature at which a solid material will change state to a liquid

Characteristics of Engineering Materials

Aesthetics

- Colour - the property possessed by an object of producing different sensations on the eye as a result of the way it reflects or emits light
- Surface texture - The roughness and variations of the surface of a material
- Finish effect - The effect on a material's surface created by adding a finish (e.g. paint, lacquer or plastic coating)

Environmental impact

- Extraction of raw material - How much energy used and environmental harm caused by extracting raw materials such as oil or metal ores.
- Fossil fuels - The use of fossil fuels as a form of energy releases CO₂ which contributes to global warming
- Sustainability - how much we can sustain (keep going) the earth's resources by carefully managing their use.