Materials & Production

Fabrics

Fabrics are made by weaving thin strands of material together to form the desired product. Jumpers, carpets, sails and parachutes are all examples of everyday fabrics

Fabrics are divided into two groups: Natural & Synthetic

Examples:

Natural: Wool, Cotton, Cashmere, Silk, Mohair

Synthetic: Nylon, acrylic, polyester

Properties:

- Soft & comfortable
- Relatively durable
- Prone to shrinkage
- Retain excess water

Wood

Wood is a natural, hard material that is the main material found in trees around the world.

Woods are divided into three groups: Hardwoods, Softwoods & Manufactured Woods

Examples:

Hardwoods: Deciduous trees - e.g. beech, oak, teak, mahogany

Softwoods: Evergreen trees - e.g. pine, deal, cedar, spruce

Manufactured Woods: MDF, plywood, laminated veneer

Properties:

- Good strength
- Flexible

- Textured (aesthetically pleasing)
- Natural grain pattern
- Prone to rotting
- Prone to fungal & insect attack
- Prone to split & shrink

Metals

Metals are divided into two groups: Ferrous & Non-ferrous

Ferrous metals contain iron and are magnetic. Ferrous metals are used in the construction industry to make railways and bridges. They will rust if untreated.

Non-ferrous metals do not contain iron and are not magnetic. Non-ferrous metals are used in electronics, aircraft components, food canning. They lighter than ferrous metals.

Examples:

Ferrous: stainless steel, carbon steel, cast iron

Non-ferrous: lead, zinc, copper, aluminium, tin

Properties:

- Shiny
- Dense
- High Melting Points
- Conduct Electricity & Heat
- Ductile
- Usually solid
- Strong
- Hard
- Malleable

Ceramics

Ceramics are inorganic, non metallic materials that are moulded and then heated and allowed to cool to make hard.

Examples:

Pottery, Spaceshuttle exterior tiling, clay, glass, bricks

Properties:

- Good heat resistance
- Hard
- Brittle
- Poor electrical conductors

Advanced Ceramics are ceramics manufactured using modern techniques and components giving them unique and amazingly powerful physical, electrical and thermal properties.

Examples:

Dental implants, bone substitutes, spacecraft components, High Performance, High Dimensional Stability Silicon Carbide Materials

Composites

Composite materials consist of a combination of different materials which are designed and engineered with a particular purpose. They show impressive improvements in their physical and thermal properties

Examples:

Cement, glass reinforced plastic, Kevlar

Properties:

- Usually stiff
- Good strength to weight ratio
- Good thermal conductance (if applicable)
- Good electrical conductance (if applicable)

Alloys

Alloys are metals that are mixed on a chemical level to give favourable properties that neither of the original components possessed originally.

Examples:

Mild steel - iron & carbon

- Inexpensive, strong, rusts easily
- E.g. nuts, bolts, washing machine bodies

Stainless steel - iron & chromium

- Hard & resistance to corrosion
- E.g. cutlery, sinks, surgical equipment

Copper - copper, tin, nickel & zinc

- Conducts heat & electricity, relatively soft
- E.g. wiring & water pipes

Aluminium - copper, tin, zinc

- Light, soft, finishes well
- E.g. aircraft bodies, lightweight vehicles, ladders

Brass - copper & zinc

- Heavy, relatively strong, yellow-ish colour, resistant to corrosion
- E.g. door handles & musical instruments

Plastics

Plastics are synthetic materials made from oil, coal, natural gas, wood or grain.

Plastics are divided into two main groups: thermoplastics & thermosetting plastics. Thermoplastics can be heated and moulded into shapes and then reheated and remoulded into different shapes many times. Thermosetting plastics can only be heated and moulded once.

Examples:

Thermosetting plastics: Epoxy resin, melamine, urea formaldehyde, polyester resin

Thermoplastics: Acrylic, High Density Polyethylene, Polypropylene, Polyester

Properties:

- Relatively light
- Good electrical insulation
- Waterproof
- Relatively cheap
- Not easily recycled
- Non-corrosive
- Non-toxic

Plastics are used in nearly every aspect of everyday life, from helmets, airbags, water bottles, mobile phones and computers

Smart Materials

Smart materials are specifically designed to respond in a predetermined way to an external stimulus

Examples:

- Thermochromic bricks are used in hot climates to change colour to lessen heat absorption
- Photochromic materials are used in sunglass & reactive glass lenses
- Self-healing materials - e.g. self repairing concrete

General Material Properties

- Strength - the ability to withstand a force without breaking or bending
- Elasticity - the ability to bend or stretch and then return to its original shape when freed from the force that was distorting it
- Plasticity - the ability to permanently change shape without breaking or deforming
- Malleability - the ability to be bent or hammered into shape without breaking/cracking
- Ductility - the ability to be deformed without breakage
- Hardness - the ability to withstand wear/scratching/indentation
- Toughness - the ability to withstand breaking or shattering
- Durability - the ability to withstand wear, especially as a result of chemical means or physical weathering
- Stiffness - the ability to maintain shape & structure when force is applied

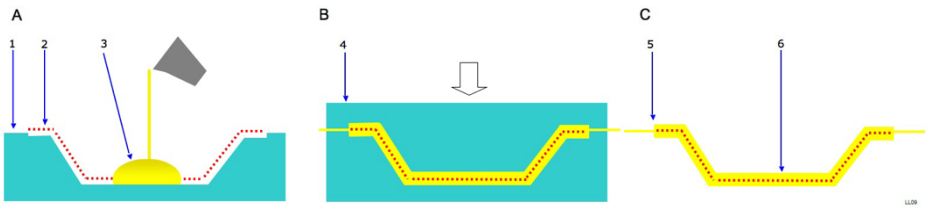
Material Selection

When selecting materials for use is a project there are a number of things you must consider:

- Safety
- Cost
- Comfort
- Availability
- Physical properties
- Environmental impact
- Environmental conditions

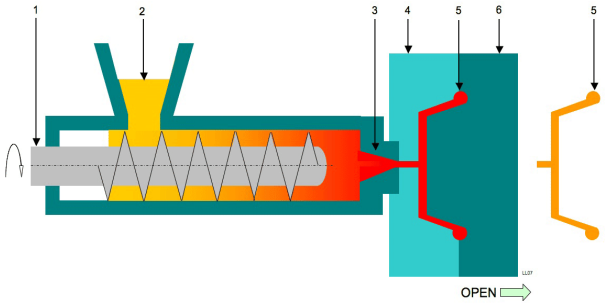
Processes

Press/Compression Moulding



Compression moulding is used to manufacture 3D shapes from sheet materials. The sheet material is placed between two halves of a mould and then the mould is pressed together and pressure is applied until the material takes the desired shape. If sheet plastic is being moulded then it may need to be heated first before moulding and then allowed to cool. This is a very expensive moulding method and is used to make artefacts such as electrical fittings and handles.

Injection Moulding



Injection moulding is usually only used on an industrial scale. It can be used with a variety of materials. The material is fed into the heated barrel of the machine and then forced into the precast mould cavity and allowed to cool and harden. Once it has hardened the mould is opened up and the newly cast mould is removed. This is a very

expensive method of moulding. It is used to make components such as bottle tops, buckets and car panels.

Finishing Methods

- Cross filing
- Draw filing
- Sanding (wet & dry)
- Emory Paper
- Polishing
- Buffering
- Varnishing
- Staining
- Waxing