Smart & Modern Materials Knowledge Organiser

Awareness of developments in new materials to aid design decisions.

As advances in technology create added functionality, new demands are placed on manufacturing to create materials that can complement the sophisticated electronics that are available.

Grapheme

Technically not a new material, but only used in commercial production since 2017, this 'material of the future' is the strongest material ever tested. Made from 100% carbon, the wonder of grapheme comes from the fact that it is an incredibly thin sheet material – it is one atom thick! The material is an excellent semi-conductor, making it useful for micro-electronics and touchscreen technology. It can be used to coat other materials, providing strength and protection to products such a helmets whilst reducing weight.

Super Alloys

This family of metals are alloys with enhanced properties. Nickel, chromium and aluminium are often used in the production of super alloys to give the resulting metals high performance capabilities. Applications tend to be in areas where weight, strength and durability are important factors, such as jet engines, space travel and energy production.

Biopolymers

These are polymers produced by living organisms and are considered important future materials, as they are sustainable, carbon neutral and renewable. Most biopolymers come from non-food agricultural crops, including sugar beet. Cellulose acetate can be produced from sugar starch and used in a wide variety of packaging applications. Its main advantage over oil-based polymer packaging is that it bio-degrades.

Nano-Materials

This family of materials are tiny particles that are designed to be added to products to give enhanced properties or characteristics. They can be found in many applications, such as cosmetics, paints, healthcare and filtrations systems. Engine lubricants make wide use of nano-materials to provide protection and longevity to moving parts.

Quantum Tunnelling Composites

QTCs are a new and novel product developed in the 1990s. The composite material is a type of semi-conductor. Electrons are able to pass through the material when it is compressed; as such is it used in clothing to allow wearers to control electronic devices beneath the material. The NASA Robonaut used QTC on its fingertips whilst in use at International Space Station. Some believe that materials such as QTC lend themselves to 'artificial skin' uses.

Smart Materials Used in Schools

Nichrome

Nichrome wire is made from an alloy that allows it to heat up without melting. It does so because it does not conduct energy well. It has many uses as a heating element and can also be used in ignition systems and detonators.

Shape Memory Alloy (SMA)

These metals can be deformed and will return to their original form when heated. This principle means design engineers can predict particular forces that the material will exert under heat and use this feature in a design solution. Most commonly available as wire and rod, they are useful in systems control projects as actuators when used in combination with electronic circuits.

Polymorph

This novel polymer is interesting to use because, although it is a true plastic which is resistant and machineable, it becomes malleable, like clay, between 30 and 60 degrees Celsius. It is useful in projects because durable iterative models and prototypes can be made quickly; because it can be shaped by hand, ergonomic solutions can also be created. Available in granular form, it becomes a soft solid when hot water is added.

Electroluminescent Material

These materials emit light when a current is applied. Available as a coated wire, easy-to-cut sheet, adhesive tape and in paint form. It has lots of potential for systems and control and textiles projects.

Thermochromic/Photochromic Materials

Photochromic pigment changes colour in strong sunlight or UV light, making it useful in situations where the user needs to be aware of the dangers of direct sunlight.

Thermochromic pigment changes colour dependant on ambient temperature.

Composite Materials

These materials are a combination of two or more different materials, brought together in such a way that the key properties of all materials work together to give a higher performing composition. Creating and using composites is almost as old as building and construction, but as new technologies in manufacturing and science advance, new ways to bring materials together are developed.

Concrete

Concrete is a mixture of cement (powdered limestone and clay), sand, stones and water. A chemical reaction occurs when the water is added that leads the concrete to set hard. This method has been used since at least the times of the Roman Empire. In the twentieth century, steel manufacturing techniques allowed thin rods or mesh to be made and set into the concrete, giving the material a much higher tensile strength. This enabled engineers, architects and builders to use concrete's quick-casting properties with much larger, adventurous forms, such as bridges, high-rise buildings and skate parks.

Manufactured Sheet Timber

Engineered timber products such as plywood, MDF and particleboard are constructed for particular uses by combining and fixing different timber elements with resins or adhesives. Almost exclusively manufactured in sheet form, most composite wood is used in construction and furniture production.

- Plywood: thin sheets of solid wood known as veneers are glued together to create stiff and light sheet material.
- MDF: fibres of timber are turned into a pulp and fixed with formaldehyde resin. The lightweight product is used extensively in flat-pack furniture.
- Particleboard: wood chips recycled from timber processing are bonded together into sheets. Whilst it has a relatively low tensile strength, it has good compressive strength and insulating qualities, so is often used in flooring and loft cladding.

Fibre-Reinforced Plastic

Commonly known as glass-fibre, this family of materials is versatile and important in large-scale product design. Traditionally, fibres of glass, which are strong and flexible, are set into a polymer resin and it put into a mould. In more recent times, carbon fibre has been used instead of glass, as it has the advantage of being much lighter and stronger, albeit more expensive. Some applications include car bodywork, boats, children's playground furniture and bicycle frames.

Robotic Materials

This field of composites are materials that incorporate sensing, communication, computing and actuation (movement). Highly sophisticated and expensive to produce, the materials are often developed to fulfil one specific role in a product. There are numerous robotic materials in existence, including plastic coatings for vehicles that allow them to camouflage themselves, as well as 'skin' for prosthetic limbs that sense touch.

Technical Textiles

Activities where physical performance is paramount, such as sports and dance, have always driven the need for not only better designed clothing, but better performing fabrics. Elastane (commonly known as Lycra™) has been a dominant material in cycling and many other sports since the 1970s, but before that, wool was considered a high performing material. As people's lifestyles change and more adventurous pursuits can be accessed by a wider audience than ever before, the demand for new fabrics that perform to exact requirements increases. Technical fabrics can also be driven by occupation; many outdoor jobs involve working in extreme conditions and technical clothing solutions can serve to improve working conditions or help make the wearer more effective at their job. Whatever the need is, what makes true technical textiles stand out is that they have outstanding properties which are particular to the context in which they will be used.

Softshell Jersey

Usually has two textile layers, most commonly polyester and polyester fleece, bonded together producing a heavy but very flexible fabric. Breathable and waterproof, softshell jersey is found in mid-season outerwear.

Airflow Mesh

This mesh fabric is 100% polyester but ingenious manufacturing makes it a very different fabric. A mesh is knitted into a lattice, giving it a strength and elasticity, as well as making it ideal for areas where structural integrity is important. Given it is a loose mesh, it is lightweight and breathable.

PowerNet

Typically a blend of polyester and Lycra, this lightweight, breathable fabric is often used in underwear owing to its body sculpting abilities.

Neoprene

A synthetic rubber, Neoprene is most commonly recognised as the fabric of wetsuits. The expanded foam textile has excellent insulating properties- meaning swimmers body heat is absorbed by the fabric along with the water, locking out cold water. It is flexible and easily bonded, which makes Neoprene useful in other applications including laptop bags, mouse mats, pipe insulation and gloves.

Ripstop

A specially woven nylon that prevents rips from spreading and ruining the fabric. Lightweight with excellent strength, the fabric has a distinctive checked pattern as a result of the heavy yarn used to reinforce the thin fabric. Used in tents, outerwear linings and bags.

Breathable Waterproof

There is a growing range of brand-named fabrics in this field of lightweight outdoor textiles. Depending on weight, these fabrics give a waterproof rating – which covers everything from showers to torrential downpours. Well-known examples include Gore-tex, Isodry and DryVent.