

Keyword	Definition
Nanoparticle	Piece of a material consisting of a few hundred atoms, and between 1 nm and 100 nm in size.
Ceramic	A hard, durable, non-metallic material that is generally unaffected by heat eg china and glass
Surface area to volume ratio (SA:V)	The total amount of surface area of an object divided by its volume
Brittle	A material that breaks before it deforms (changes shape)
Strong	A material that resists both deformation (changing shape) and failure (eg snapping)
Hard	A material that resists dents, scratches etc
Stiff	Resists deformation (changing shape)
Malleable	A material that can be hammered or pressed into shape without breaking

Polymers

- A wide range of polymers exist with differing physical properties such as strength, stretchiness, density, ease of moulding etc
- The properties of a polymer determine its use.
- Strong, rigid polymers (eg high-density poly(ethene), HDPE) are used to make water pipes.
- Light, stretchy polymers (eg low-density poly(ethene), LDPE) are used to make carrier bags.
- Poly(styrene) foam is used for packaging and thermal insulation
- Heat resistant polymers (eg poly(propene), PP) are used to make kettles.

Ceramics

- Ceramics are stiff, brittle, strong and hardwearing materials that are electrical and thermal insulators. They are resistant to corrosion and do not degrade overtime like some other materials.
- They are produced by heating substances to high temperatures such as clay to produce bricks and china, and sand to produce glass.
- Glass is different to other ceramics as the atoms inside it are not arranged regularly and so glass is transparent.

Metals

- Metals are good thermal and electrical conductors. They are malleable, strong, have high melting temperatures and typically have a high density and are less brittle than ceramics or polymers.
- Some metals corrode easily (eg iron) but corrosion resistant metals can last a very long time (eg copper, gold).
- Metals can be mixed with other elements to form alloys (such as steel) that can have improved properties such increased hardness or corrosion resistance over individual metals.

Composites

- Composites are made from two or more materials with different properties. The properties of the composite depend on the materials used to make it.
- Composites (eg reinforced concrete) are made from a reinforcing material (iron bars) embedded in a matrix/binder (concrete)
- The component materials can be changed to obtain a material with the properties needed for a specific use.
- The cost of producing composites is their main disadvantage.



Nanoparticles

- Nanoparticles contain only a few hundred atoms. They are larger than atoms (~0.1 – 0.5 nm) and simple molecules (eg O₂) but are smaller than nearly everything else.
- A nanoparticle has very different properties than the bulk material – eg fullerenes (carbon nanoparticles) have different properties than a lump of carbon. Gold nanoparticles will change colour from red to purple depending on the size of the particles.
- Nanoparticles have extremely high surface area to volume ratios which means a greater proportion of their atoms can interact with substances compared to their bulk material.

Nanoparticles and health

- The full impact of nanoparticles on health is not yet fully understood. New products need to be tested to minimise risks to health.
- Some people worry that products containing nanoparticles are available without full investigations into possible side-effects or long-term impacts of their use on human health or the environment. The higher surface area to volume ratio could mean they are more toxic compared to their bulk materials.
- For example, some nanoparticles used in medicines do not break down easily so could build up in cells. Breathing nanoparticles in could lead to breathing issues such as inflamed lungs.

Uses of nanoparticles

- The high surface area to volume ratios means nanoparticles can make excellent catalysts as reactions can take place on the surface of the nanoparticles.
- Some sunscreens use certain nanoparticles as they absorb UV light without leaving white marks on the skin.
- Nanomedicines using fullerenes that contain drugs are being developed. Fullerenes are more easily absorbed into the body than most particles and could deliver drugs into cells where they are needed.
- Carbon nanotubes conduct electricity and can be used to make smaller parts for computers.
- Certain nanoparticles can be added to plastics in sporting equipment to make them stronger without adding much mass
- Silver nanoparticles have antibacterial properties and can be added to polymer fibres used to make surgical masks and wound dressings.

