Discovering new materials

What are **nanoparticles** and **smart materials**? What are they used for?

One nanometre is one billionth of a metre. A human hair is about 80 000 nm thick. The largest atoms are just over 0.5 nm across.

Atoms, molecules and nanotechnology

Atoms and molecules are far too small to see, even with the most powerful microscope. They are so tiny that they are measured in **nanometres** (nm), 1×10^{-9} metres.

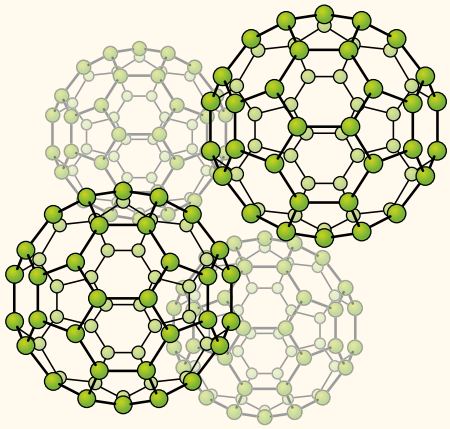

Figure 5.1 *Molecules of* ***fullerene*** *have a diameter of approximately 1 nm. Fullerene is an unusual form of carbon, made up of molecules containing 60 carbon atoms (C_{60}).*

Nanotechnology

Nanotechnology is the science of building and controlling particles whose sizes range from 10 to 100 nanometres. The idea of building molecules, atom by atom, seems incredible but nanotechnology has enormous potential.

Some useful nanoparticles have already been developed. ICI have produced nanoparticles of titanium dioxide that absorb harmful UV rays. They are used in high-factor sunscreens that appear invisible on the skin and in sun-protective clothing. **Nanocomposite** plastics have also been produced – these are stronger and stiffer than ordinary plastics and are used in the car industry, dentistry and medicine.

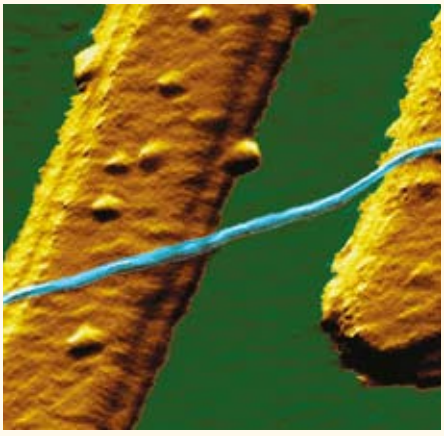

Figure 5.2 *Carbon nanotubes could be used to make smaller and faster computers on the molecular scale.*

Some scientists even believe that self-replicating molecules could be built and be programmed to do certain jobs. These **nanobots** could be used to build tiny machines on the molecular scale. However, some people are concerned about possible problems caused by using nanotechnology. For example, some are worried that self-replicating materials could get out of control. Like all advances in science, we must consider the advantages, but still be aware of possible dangers. To weigh up these choices we all need some scientific understanding and we all need to be involved.

1 How many nanometres are there in a metre? *[Total 1]*

2 A virus measures 100 nanometres across. What is that in metres? *[Total 1]*

3 What is special about nanotechnology? *[Total 1]*

Billions of pounds are being spent on research and development (R&D) into nanotechnology. However, many scientists believe that the creation of useful nanoparticles, that can control their own actions, is a long way off – and may never happen.

Figure 5.3 *Sometime in the future, doctors might use millions of nanobots to clean up your arteries.*

4 a) What is R&D? *[1]*
b) Why is it important? *[2]*
[Total 3]

Smart materials

Another range of new substances that have great potential are 'smart materials'. These substances respond to changes around them in a consistent way. New smart materials can expand or contract through small changes in temperature, pH or electric current. Some scientists think that these could be used as artificial muscles, but much more research is needed.

Figure 5.4 *This 'smart spoon' changes colour if the food is too hot.*

Questions

1 What are nanometres, nanoparticles and nanobots? *[Total 3]*

2 This question is about the uses of nanoparticles.
a) List two examples in practice today. *[2]*
b) List three examples of possible uses in the future. *[3]*
[Total 5]

3 What problem could arise from using self-replicating nanoparticles? *[Total 2]*

4 Suggest a possible use for a 'smart fabric' that changes colour with changes in:
a) light *[1]*
b) moisture. *[1]*
[Total 2]

5 Why do we all need some understanding of science? *[Total 2]*

6 Design a poster for a lecture on nanotechnology. Your poster should have an interesting title, and drawings to illustrate the new technology. *[Total 10]*