

**SMART MATERIALS**

A smart material is a material that can be controlled. It can be made to change its colour, size or shape and be returned to its original form at will.

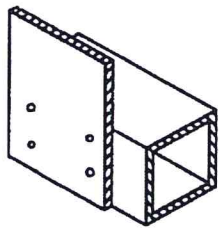
The control input can be changing the temperature of the material, applying an electric current through the material or by applying pressure to the material.

**Shape-Memory Alloys**

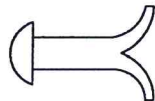
Shape-memory alloys (SMAs) have two distinct molecular structures at different temperatures. If they are reshaped when cooled, they will return to their original shape when heated back to room temperature.

The nickel-titanium alloy, Nitinol, is used for medical and space components, fasteners, water sprinklers and pipe connections.

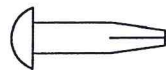
e.g. Nitinol can be used to make a self-opening split rivet. The diagram below shows sheet metal riveted to square tubing. You cannot easily get inside the tube to open the split rivet.



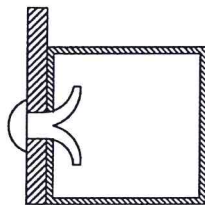
At room temperature the split rivet is in its open position.



When cooled to below freezing, the rivet becomes straight.

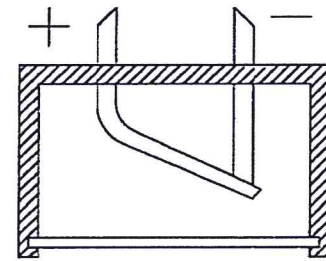


When cold and straight the rivet is placed through the hole and is allowed to heat up to room temperature. The rivet then opens up inside the tube and holds the sheet and tube firmly together.



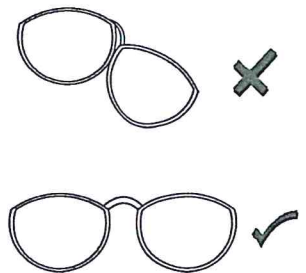
The diagram shows an artificial hip joint. When it is cooled the teeth lie flat and allow it to be inserted into the top of the thighbone.

When the temperature of the joint rises to that of the body, the teeth curve out and grip the inside of the hole in the bone and stop the joint from moving.



The diagram shows a detector for a fire alarm sprinkler system. When a fire raises the temperature, the positive (+) contact straightens and breaks the circuit, this will trigger the sprinklers.

Glasses frames that remember their shape are made from a SMA. If the glasses are sat upon and the frames are twisted, the alloy remembers its room temperature shape and returns to it.



**Shape-memory Plastics**

Shape-memory plastics (SMPs) are also being developed. Different plastics have different recovery temperatures. There are currently five grades that change shape between 40°C and 80°C. These can be used to sense temperature change because they change shape when a certain temperature is reached.

1. What is special about a smart material?
  2. What are the methods used to control smart materials?
  3. What do SMA and SMP stand for?
  4. Which metals make up the alloy Nitinol?
  5. Explain, with diagrams, how you use a Nitinol split rivet.
  6. How can Nitinol be used to prevent fire damage?
  7. How can a person with a hip problem be helped by an SMA?
  8. Give an example of how an SMA can self-repair damage.
- A** Describe fully three possible uses for SMP material.
- B** Design a household or garden product that might make use of SMA or SMP materials.

**KEY WORDS** Smart: SMA: Nitinol: SMP: