

What is a shape memory alloy?

Let's start by defining what we mean by a "shape memory alloy." An alloy is a metal containing two or more elements. Thermal shape memory is the ability of a material to return to its original shape when heated.

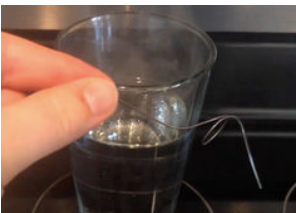
The piece of wire in this demo is called Nitinol and is an alloy made of nickel and titanium which has two phases or states: a high temperature state (austenite) and a low temperature state (martensite). The difference in the two states is the arrangement of the atoms in the wire.

The low temperature phase is weaker, allowing the material to be bent and pulled out of shape. When deformed at a low temperature and then heated, Nitinol will return to the shape established when in the high temperature, stronger phase.

By heating the material, the atoms are given enough energy to rearrange themselves back to their high temperature phase. This ability to remember and revert to the original shape gives this material the name "shape memory."

In comparison, a piece of normal steel wire (whose composition is generally iron and carbon) will be unaffected by the addition of heat and will maintain its deformed shape.

Nitinol is a popular choice for a variety of applications: as a material in temperature control systems, springs in orthodontic braces, and for eyeglass frames.



Experiment

The piece of Nitinol wire in this kit was heat treated or set to be straight in its original (austenite) phase. During this demo, the atoms in the wire will undergo a phase transformation between the low temperature martensite and the high temperature austenite.

Take the wire and wrap it around your finger to form a spring shape*. It will remain in that shape until it is heated to its transformation temperature. Obtain a cup of hot, nearly boiling water (please be careful!). Hold on to one end of the wire and dip the other end into the hot water (you can use pliers if you want). What happened?

If the water was hot enough, you could feel and see the wire trying to straighten itself. That's because once the wire is heated above its transformation temperature, it will return to the austenite phase and its original shape set.

Try coiling the wire into a tight spring and tossing it into the water. If done correctly, the nitinol wire will "jump" out of the beaker! Please, be careful here too!

*Do not make sharp corners in the nitinol wire or tie it into knots. The wire is limited on how much deformation it can recover from.

Nitinol stents can be inserted into a blocked artery where the temperature of the body is warm enough to trigger a reversion to its original expanded shape, opening the artery enough for proper blood flow.

To access the video demonstration and additional teaching materials, scan the QR code below!



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