Exploring Materials—Memory Metal

How can a metal "remember"?

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Exploring Materials—Memory Metal

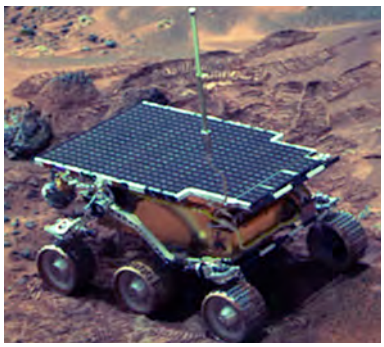
Try this!

1. Stretch out the NiTi spring.
2. Hold the stretched-out NiTi spring by one end, and use the "high" setting of the hair dryer to heat it up. What happens?
3. Does the ordinary steel spring do the same thing when it's heated with the hair dryer?

What's going on?

The NiTi spring returns to its original shape when heated by the hair dryer, but the steel spring doesn't. NiTi is an alloy of nickel and titanium called *nitinol,* or *NiTi*, for short. It's also known as "memory metal."

Memory metal changes between two solid structures, a low-temperature phase and a high-temperature phase. The spring changes shape because its atoms rearrange themselves during this phase change. Each atom moves only a tiny bit, but there are so many atoms in the spring that the movement is big enough for you to see.



Mars rover

Some NiTi alloys respond to electricity, rather than temperature, to change shape. For example, the Mars rover Sojourner uses a NiTi wire to shake dust off a solar cell. The NiTi wire is heated, which shortens it and pulls the cover open. This allows the cover to shed accumulated dust, so the solar cell can gather energy from the sun.

The properties of smart metals make them useful for many applications. The most familiar use of NiTi is the dental arch wire and springs used in orthodontic braces. Other commercial products include eyeglass frames, cell phone antennas, and surgical staples.

Now try…

1. Stretch out the NiTi spring.
2. Attach it to the handle of the pail.
3. Add a few pennies to the pail.
4. Use the hair dryer to heat the spring again. Can the spring lift the pail?

How is this nano?

The way a material behaves on the macroscale is affected by its structure on the nanoscale. Changes to a material's molecular structure are too small to see directly, but we can sometimes observe corresponding changes in a material's properties. Memory metal changes size and shape as a result of nanoscale shifts in the arrangement of its molecules.

Nanotechnology takes advantage of special properties at the nanoscale to create new materials and devices. Researchers are investigating the use of memory metal in heat engines. Memory metal is already used in a variety of technologies, from orthodontic braces to satellites.