

# NITINOL | MEMORY METAL

## GOALS/PURPOSE

- Learn about nitinol, a shape memory alloy that exhibits a solid state phase change with interesting and useful properties

## MATERIALS/EQUIPMENT

- 1 piece of Flinn Scientific nitinol “Live” Wire per student. *\*See below for specifics on purchasing*
- Beaker
- Water

## PROCEDURE

1. Straighten or deform a piece of shape memory metal. Dip the distorted wire into a beaker of water at approximately 70 °C (or higher based on which alloy you have). It returns to its original shape.
2. Test different samples and shapes. (A hair dryer may also be used as a source of heat.)
  - a. Hold the metal in the warm water using pliers on each end.
  - b. Deform the metal and release the wire from one of the pliers—it will be elastic, not pliable.
3. If available, straighten or attempt to deform a piece of super-elastic metal. It springs back to its original shape.
4. Dip the super-elastic metal into a dry ice/ethanol bath and immediately straighten or deform the metal upon removal—it will now relax and deform. It will return to its original shape as it warms in the air.

## INSTRUCTOR NOTES

- Nitinol is named for **Ni** (nickel) **Ti** (titanium) **NOL** (Naval Ordnance Laboratory)
- Some applications of these materials include stents, flexible glasses frames and wires for braces.
- A solid state phase change occurs at a specific transition temperature. A crystal structure change occurs—more pliable structure at cooler temperatures and an elastic structure at warmer temperatures.
  - By varying the percentages of nickel and titanium in the alloy, different transition temperatures can be achieved.
- Shape memory wire—transition above room temperature
- Super-elastic wire—transition below room temperature
- The “set” shape of a piece of nitinol can be changed by using a heat treatment around 500°C.
- Source of nitinol wire and products and information about heat-treating and phase changes of nitinol:
  - <https://www.imagesco.com/nitinol/nitinol-index.html>
- Mechanics of the nitinol shape memory effect:
  - <https://www.imagesco.com/nitinol/files/nitimm.pdf>
- Informative article on nitinol:
  - <http://wychem.scienceontheweb.net/ChemCD/ChemMatters/931004t.pdf>

### Sources of Nitinol:

- **Flinn Scientific (FlinnSci.com)** | Catalog number: AP1937.
- **Educational Innovations (TeacherSource.com)** | Catalog number: HS-6 by the foot; HS-9 package of ten 3-in. pieces