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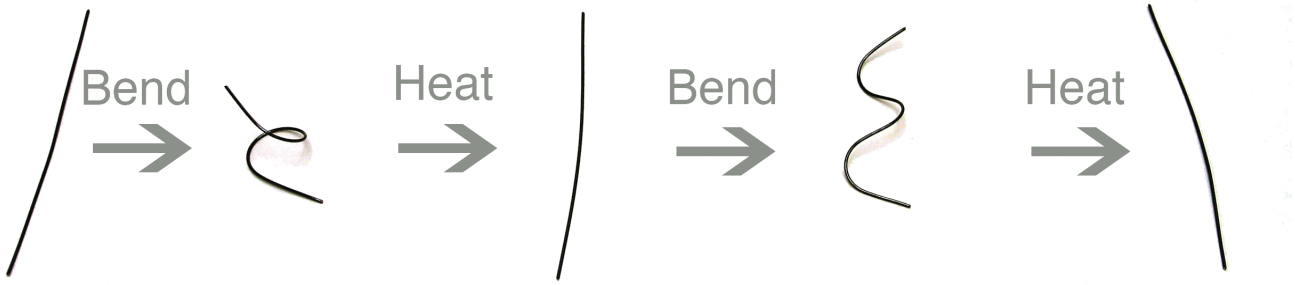
Educational Innovations, Inc.®

Nitinol Memory Wire

HS-6 / HS-9

NiTinol memory metal has two crystalline phase forms with a transition temperature between 30° and 50° C. At high temperature, the NiTi alloy prefers the Austenite phase while at low temperature, the alloy prefers the Martensite phase. Because the Martensite phase crystal structure consists of a series of planes which may be displaced, it can be deformed. The Martensite structure has 24 different variants to carry out this transformation and, as a result, can be deformed in nearly any direction. When the alloy is heated to the Austenite phase, the planes are slid back into place and the structure reverts to its original form. Thus, the metal appears to 'remember' its original shape.



Demonstration #1

Memory Metal Remembers its Austenite Shape

1. Place a sample of NiTi wire on an overhead projector and examine its shape.
2. Bend or coil the wire and return it to its stage of the projector. You may want to fasten one end of the wire with a piece of transparent tape.
3. Heat the wire with a hair dryer and watch it straighten out as it returns to the preferred higher temperature Austenite phase.
4. Alternatively, the bent NiTi wire sample can be dropped into a projected petri dish containing hot water.
5. Still another variation of this demonstration uses resistive heating to change the NiTi wire to its Austenite phase. Simply connect each end of a short sample wire to a 9-volt battery (1 D-cell batteries in series may be substituted) for a few seconds. As the wire resistively heats, it returns to its Austenite phase.

Demonstration #2

Setting NiTi Wire into a New Shape

1. Place a sample of NiTi wire under tension by bending it, and hold so that the wire maintains its bent shape.
2. Holding the wire carefully so as not to burn your fingers, bring the bent end of the NiTi wire *close* to a candle or Bunsen burner flame. Heat it slowly until you feel a release of tension. At that point, remove the wire from the vicinity of the flame. Note: do not heat the wire more than is necessary to release the tension.
3. Let cool. The NiTi wire has now been set into a new shape.
4. Repeat demonstration #1 to show that heating the wire will now cause it to return to its new bent shape.

NiTinol 'memory' wire is available from Educational Innovations in two forms.
1. 3" samples sold in packages of 10. Item #HS-9
2. Longer lengths which are sold by the foot and are larger in diameter (~.030"). Item #HS-6

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NGSS Correlations

Our Nitinol Memory Wire and these lesson ideas will support your students' understanding of these Next Generation Science Standards (NGSS):

Elementary

2-PS1-2
Students can analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

2-PS1-4
Students can use the Nitinol Wire in an investigation to construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.

5-PS1-3
Students can use Nitinol Wire to make observations and measurements to identify materials based on their properties.

Middle School

MS-PS1-2
Students can analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

MS-PS1-4
Students can use Nitinol Wire to develop a model that predicts and describes changes in particle motion, temperature, and state of pure substance when thermal energy is added or removed.

MS-PS1-6
Students can use Nitinol Wire in the design of a project. Students can construct, test, and modify a device that either releases or absorbs thermal energy.

High School

HS-PS1-5
Students can use observations made of the Nitinol Wire as evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which the reaction occurs.

HS-PS2-6
Students will observe and communicate scientific information about why the molecular-level structure is important in the functioning of a material.

Suggested Science Idea(s)

2-PS1-2 • 2-PS1-4 • 5-PS1-3 • MS-PS1-2 • MS-PS1-4 • MS-PS1-6 • HS-PS1-5 • HS-PS2-6

Students can conduct simple tests using Nitinol Wire to understand the rate at which the wire will straighten when immersed in hot water. Students can run trials to evaluate Nitinol Wire based on its properties and/or the reactions.

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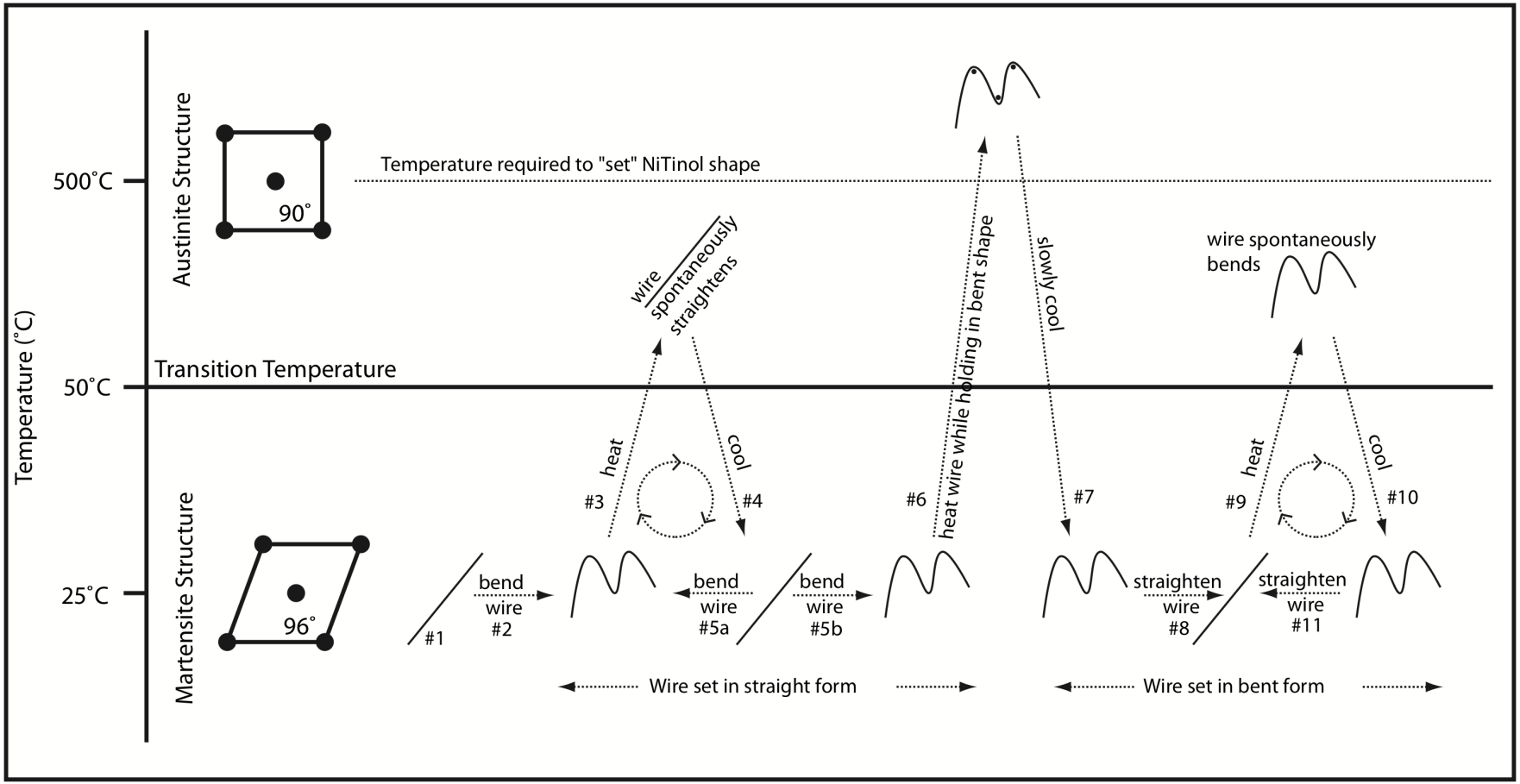
Mechanics of the Nitinol Shape Memory Effect



The wire is usually purchased “set” straight (step #1). Below the transition temperature, the Marstensite form of the wire can be bent quite easily (step #2). When heated to the transition temperature (step #3), the unit cells change to the Austinite form and its originally “set” shape. The cycle (steps #4, #5a and #3) can be repeated many times. To “set” the wire into a new shape, heat it to 500˚C while restricting its movement (steps #5b, #6, and #7). The new cycle (steps #8, #9, #10, and #11) can be repeated many times.

Take Your Lesson Further

As science teachers ourselves, we know how much effort goes into preparing lessons. For us, "*Teachers Serving Teachers*" isn't just a slogan—it's our promise to you!

Please visit our website for more lesson ideas:

TeacherSource.com/lessons

Check our blog for classroom-tested teaching plans on dozens of topics:

http://blog.TeacherSource.com

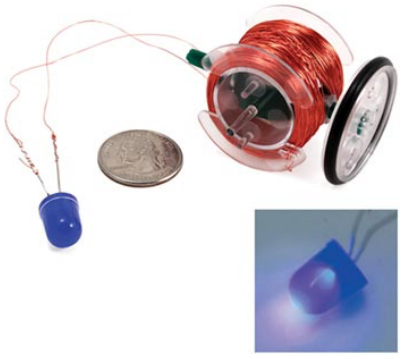
To extend your lesson, consider these Educational Innovations products:

Nitinol Spring (HS-620)

What's so special about a piece of coiled wire? Plenty. Our spring is made of nitinol, an amazing metal that can be twisted or straightened but will always return to its original shape when dipped into hot water (~45°C). Talk about discrepant events—this wire is practically magic! An alloy of nickel and titanium, nitinol (Ni-Ti) falls into a sophisticated class of materials known as shape memory alloys that 'remember' their original shape. Perfect for classroom demonstrations. Comes with a Teacher's Guide.

World's Simplest Motor (SS-11)

This easily assembled motor is able to run for more than five hours on a simple D-Cell (flashlight battery). Recommended for ages eight and up. Requires D-Cell battery, not included.



The Transparent Alternator Kit (OHM-150)

Our ingenious Transparent Alternator Kit has been designed to take the mystery out of how electricity is produced. This little device can be assembled easily in 20 minutes without tools. That's when the discoveries begin! What can you power with your alternator? How is electricity generated from a magnet and some copper wire? A wonderful hands-on introduction to electricity. With modifications, you can produce enough electricity to charge a cell phone! Once built, this alternator can be unwound, disassembled, and rebuilt over and over again.