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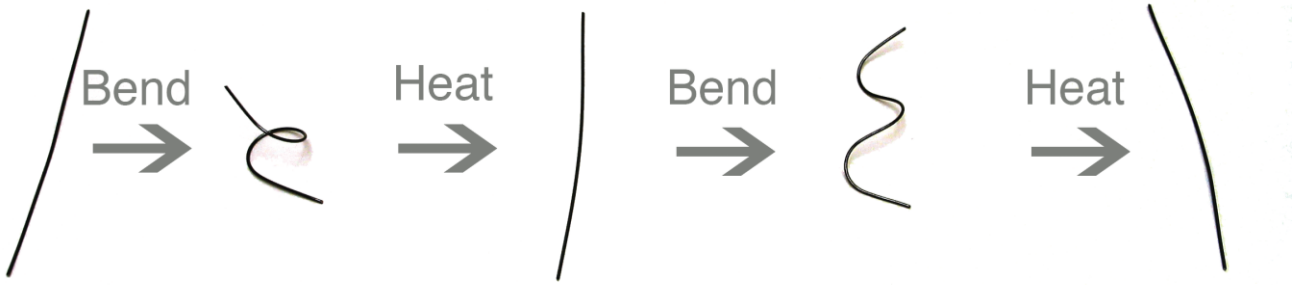
Nitinol Memory Wire

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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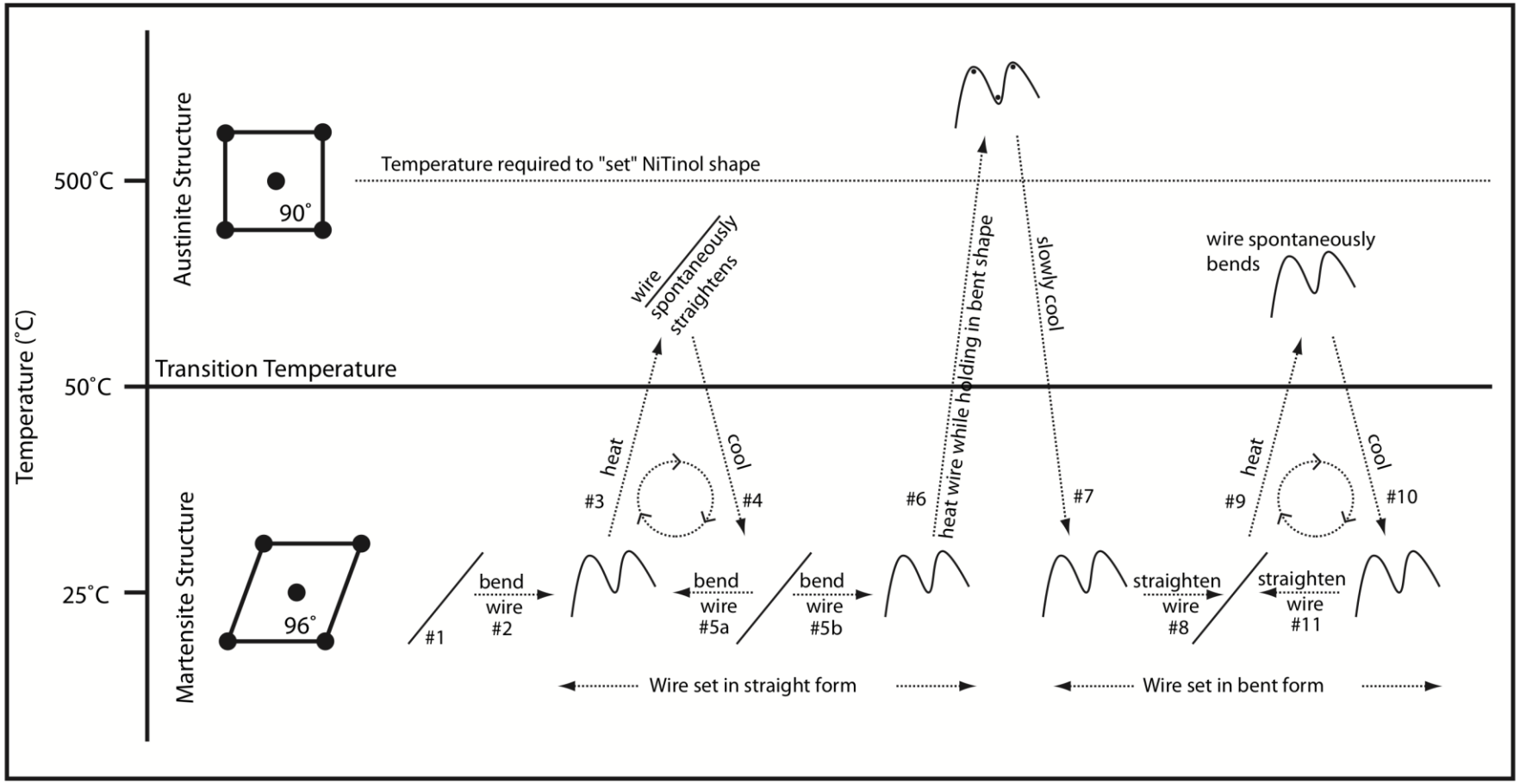
Mechanics of the Nitinol Shape Memory Effect



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.

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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.

Exergia Memory Metal Engine Learning Kit (HS-200)
This is a very special kind of heat engine that demonstrates the conversion of heat into mechanical energy. It uses the unique property of Nitinol alloy (~50% Nickel, ~50% Titanium, the 'nol' at the end of Nitinol refers to Naval Ordnance Laboratory in Maryland USA where this alloy has been developed) called the 'memory effect.' Once Nitinol has been formed into shape at high temperature (about 600°C) and allowed to cool to room temperature, it can be easily deformed. However, when heated above a transition temperature (in this application about 50°C to 70°C), the Nitinol object abruptly returns to its high-temperature shape with substantially more force than that required to deform it when cold. Uses a Nitinol wire formed to a closed loop that drives the two connected wheels.