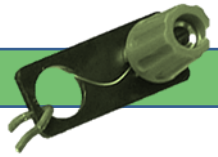


# Shape memory effect



## Equipment

- Nitinol wire (3-4 cm)
- hot water (around 90°C)
- clear see through glass
- pliers
- candle
- 2 metal pliers with insulating handles
- temperature probe

## Safety notes

Careful as you handle hot water!

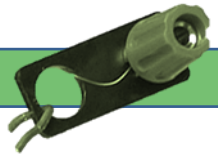
Wear googles or keep your face at safety distance as you drop the wire in the hot water since it tends to spring as soon as it hits the hot vapor.

## Procedure

### *Qualitative Demonstration*

1. Bend the wire into the desired shape.
2. Fill the glass with hot water (approx. 80°- 90°C ).
3. Drop the wire into the water. What happpens?
   *Notes and observations* :
   ……
4. Take the wire out with pliers and repeat many times from step 1 to 4, you may also decide to change shapes .
5. Answer the following questions:
   *a)What's responsible for triggering the shape recovery?*
   ……

   *b) Which is the physical parameter you have to investigate? How do you think you will monitor it?*
   ……



## *Semi-quantitative study – evaluation of the activating temperature*

Your **objective** is to determine with the utmost precision the temperature(s)/ at which the shape recovery is activated. Once you have completed your observations you will be asked to compare results with the other groups.

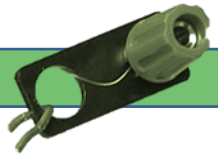
1. Decide an appropriate time interval for data collection : $\Delta T$ = ……
6. Fill the glass again with hot water (approx. 80°- 90°C ) and put the temperature probe in.
2. Drop the wire into the water at regular time intervals, recover and bend it again each time.
3. Write down the water temperature together with your observations in the table

| *Temperatura °C* | *Osservazioni sul recupero forma del filo* |
|---|---|
| | |
| | |

4. In your investigation you should have pinned a specific temperature or temperature slot for the shape recovery activation : which one? ……
5. Discuss with your fellow students whether to refine your investigation by repeating the whole process with a smaller $\Delta T$ and in case also whether to start from an initial temperature below 90/80°C. Write down the new "critical interval" that you have found: …….

## *Analysis and food for thought (for classroom debate)*

1. Does Nitinol exhibit one specific transition temperature or just a range of temperatures?
   ……
2. Have you got any suggestions on how to implement better the experimental procedure?
   ……
   ……
3. What's the behavior of a metal upon heating as a rule? Is Nitinol behavior comparable? Why? On which observations is based your answer?
   ……
   ……



## *Nitinol wire retraining*

One of Nitinol most peculiar characteristics, even from the applicative point of view, is the possibility to "retrain" its memory. This can be achieved by bending the wire in the desired shape and exposing it to a very high temperature such as a candle flame.

Careful: free flame!

1. Light the candle and using two pliers with insulating handle put the Nitinol wire on the flame and keep it there.
2. The wire will attempt to spring back into the original shape. You will need to hold it very firmly at the two ends with the pliers to keep it from moving.
3. After a short time over the flame you will feel the wire relaxing. It is now retrained into the new shape!
4. Test the new memory with the usual procedure: bend it into a different shape and drop it into hot water.

## *Analysis and hints for classroom discussion*

1. **Applications** – Discuss with your group one or more possible applications of the Nitinol shape memory. Evaluate in each case the ideal activating temperature.
2. **Science communication** – due to its unusual and quite spectacular behaviour Nitinol is perfect for demonstration activities. Discuss how to change and possibly reorganize the path followed here in order to present it to other classes: the message you want to pass on should a be a very clear and simple scientif idea and you should certainly exploit the high wow factor . (10 min max)

   Which message do you want to transmit? How can you effectively catch attention and bring people to participate ?