Student Worksheet or Guide

Shape Memory Alloys- Smart Materials

Materials

- Nitinol wire
- Tweezers
- Shallow glass bowls or dishes
- Hot water, heat guns, candles and matches, candle holders
- Safety glasses

Background

Shape memory alloys are a class of materials also referred to as smart materials. These smart materials can "think" and do amazing things. The one this activity focuses on is a metal called nitinol.

Shape memory alloys (SMA) belong to a class of materials which display the shape memory effect (SME). These alloys possess the ability to radically change crystal structure or phase at a distinct temperature. Imagine the ability to change water into ice, or steam into water instantaneously. Unlike most metals, if the alloy is below the "transition temperature," it can be stretched and transformed without permanent damage.

Directions for the Activity

1. Your teacher will direct you to obtain a bowl, wire pieces, tweezers, and safety glasses. There will also be a source of hot water for this activity.
2. Your teacher will demonstrate to the class the ability of the wire to instantly transform back to its original shape.
3. Next pour hot water into your bowl, twist the wire, and then insert it into the hot water. What happened? Use the tweezers to retrieve the wire from the hot water. Why do you think this change happened? Try it a few more times and record your results (you may need additional hot water).
4. Next you will set your wire into a specific shape. Simple shapes like a V or S are the easiest to set with the heat source you will use. Light your candle and using the tweezers to hold the wire on both ends (it will try to return to its original shape once it reaches its transition temperature), insert it into the flame. The wire should set in about a minute. You should feel a relaxation of the tension in the wire. Allow the wire to cool, then put it into a new shape or stretch it out straight. Place in hot water or back into the flame. What happens? Can you explain how this happened?
5. What are the possible uses for shape memory alloys? Can you think of some applications you would like to see these smart materials used for? What would be the benefit? How would you market the product?

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Safety Information
The only safety precautions involve:

- The possibility of the wire "jumping" from the dish
- Spilling of hot water
- Use of candles/flames

Nitinol sources – specify a diameter of around 0.29" and a transition temp of about 50^{o}C
http://www.teachersource.com
http://www.imagesco.com.nitinol/wire.html
http://www.smallparts.com/products
http://www.robotstore.com

Additional Information on Shape Memory Alloys
http://www.imagesco.com/articles/nitinol/01.html
http://www.cs.ualberta.ca/~database/MEMS.sma_mems.sma.html
http://www.mrsec.wisc.edu/Edetc/supplies/index.html
http://web.ask.com/web?q=shape+memory+alloys&o=0&qsrc=0
http://smart.tamu.edu/overview/smaintro/simple/definition.html
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