Investigation 3
Properties of Martensite and Austenite

Part I: Review

1. In the last investigation, we matched each phase of NiTi with its structure. Martensite is found in which temperature phase, high temperature or low temperature?__________ . Austenite is found in which temperature phase, high temperature or low temperature? __________

2. What we learned in Investigation 2 can be summarized by the following equations:

   Equation 1: martensite + energy = austenite

   Equation 2: austenite – energy = martensite

In your own words, restate what each equation means.

Equation 1:

Equation 2:

3. As you have already learned, Nitinol is a mixture of nickel and titanium. By slightly changing the amount of nickel that is mixed with the titanium, material scientists can change the temperatures at which Nitinol changes from martensite to austenite. Depending on the mixture, Nitinol can be in the martensite phase at room temperature or in the austenite phase at room temperature.
4. You will be given two samples of Nitinol. One is in the austenite phase, the other in the martensite phase. One is called Sample A and the other Sample B. Try to bend each sample. Which sample is the martensite phase? __________________How can you tell?

5. Try scratching the samples with one another. Which sample is scratched by the other? ______________________

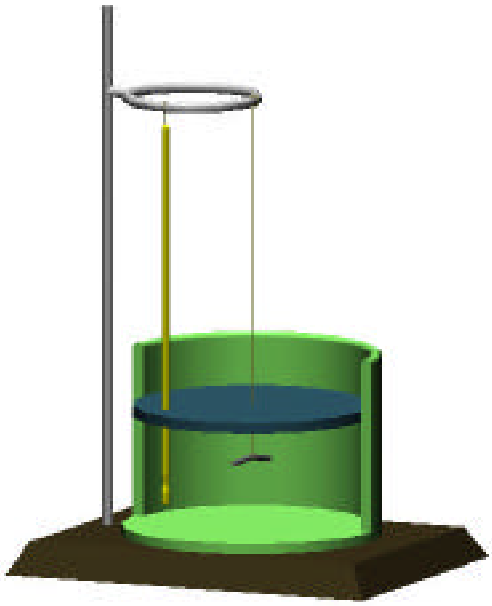
Part II: Moving from Austenite to Martensite

6. Place the austenite sample in the liquid nitrogen or dry ice/ acetone bath. What happens? Why?

7. After bending the cold sample, how do you return it to its original shape?

Part III: Transition Temperature

As you found out in Investigation 1, a martensite sample can be returned to it original shape by heating it with hot water. By changing how much nickel is in the NiTi, material scientist can change how warm the martensite has to be before it returns to the austenite phase. This is called the **transition temperature**. This is the temperature at which the wire changes from austenite to martensite and vice versa.



8. Bend the martensite sample. Set up your equipment as shown above (beaker is cut open to show placement of the Nitinol and thermometer). It is very important that the neither the thermometer nor the memory metal sample touch the bottom of the beaker or hot pot since the temperature of the heat element or the beaker will not be the same as the temperature of the water. Tie a string to the martensite rod so it can be suspended in the hot water. Slowly heat up the water in the beaker. As the water is heated, you will probably notice that the wire begins to straighten out. Carefully observe the wire. When it has become completely rigid and has returned to its original shape, record the temperature. This is the transition temperature. At what temperature does the sample fully transform into austenite? _______________

Part IV: Analysis

9. Obtain the transition temperatures of all the other students in the class. Average the data. What is the average transition temperature? _______________

10. Use the graph on the next page and determine what percentage of nickel the wire sample contains using the average transition temperature data above. What percentage of the sample is nickel? ____________________

11. If you wanted to use Nitinol that become soft and flexible when placed in an ice bath (0 C), about what percentage of nickel might you use? Select one.

a. 49.5% b.50.0% c. 50.5% d. 51.0%

12. Flexible, “unbreakable” eyeglass frames are made with Nitinol memory metal in the austenite phase at room temperature. If the frames are made with 50.5% nickel, what might happen to eyeglass frames worn in Antarctica on a very cold day (about – 60 C)? Explain.