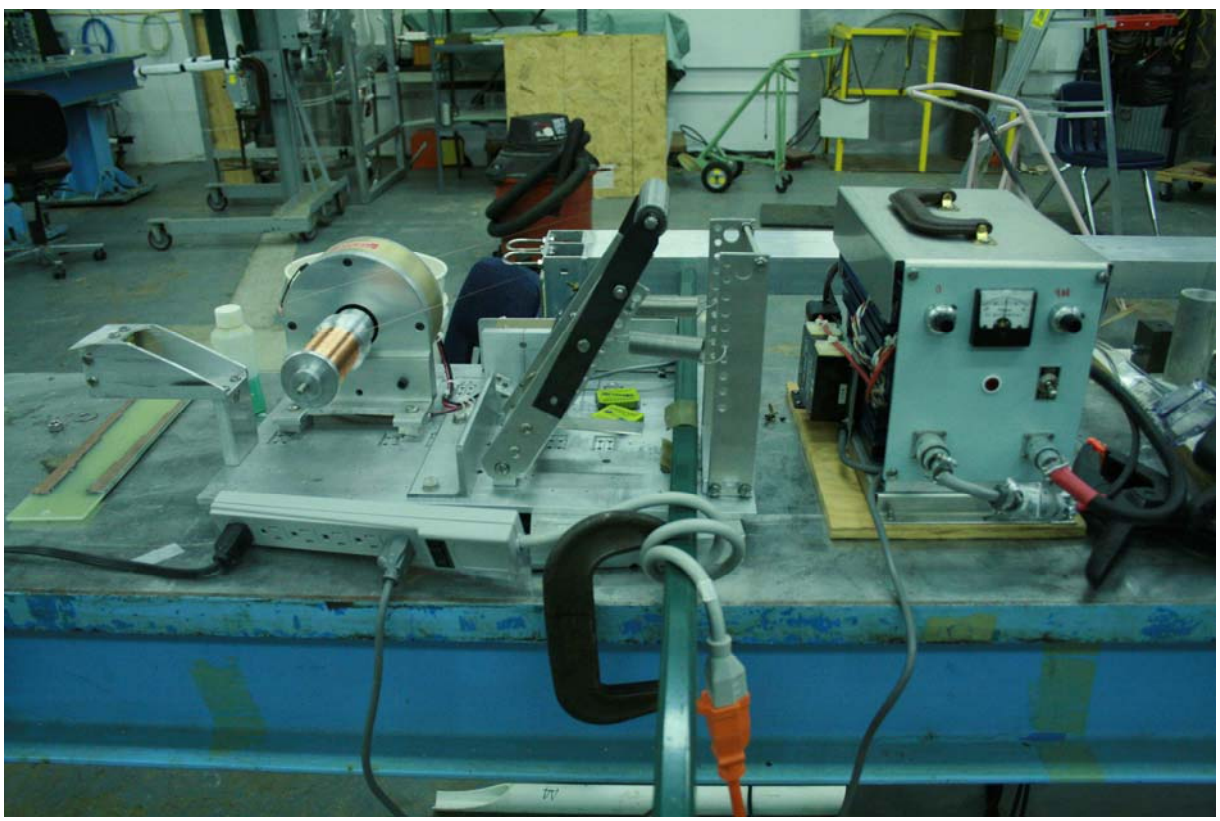
WIRE Solder Test.

Juan Solano August 15, 2008

The purpose of this test is to see how well solder will hold wire at a given tension. They relationships being tested are as follows. The length of the solder and the amount of time it would take for the solder give too much causing the wire to loose its tension. The type of solder and the time it would take for the wire to loose tension. We would test all lengths at different tensions.

The first process was to make a card that consisted of 96 wires. Every wire on the card would begin with approximately the same tension. Some changes would occur due to friction. (See picture of the tension machine) The machine kept a specific tension determined by the springs, and a motor that would maintain a lever at a specific level. We would check for the tension in each wire by finding the resonance frequency of the string at the specific tension. Using the formula $f = \frac{1}{2l}\sqrt{\frac{\mathrm{T}}{\rho}}$ and then solving for T, I get $\mathrm{T} = 4*(lf)^2 * \rho$ where $\rho = .000152$, $l = length$ of the wire, and $f =$ the resonance frequency. I measured each wire then found the resonance frequency using a frequency generator. This allowed me to continue checking the tension of each wire over time.

(Wire Tensioning Machine)



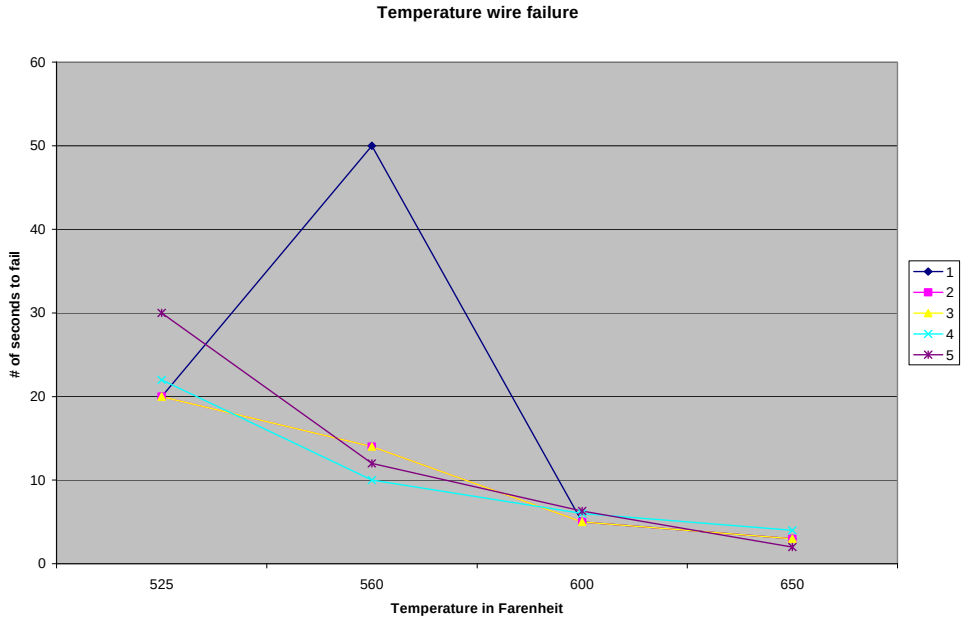
Originally the plan was to make 4 cards which consisted of 6% Au solder, 4 cards that consisted of 2 %Au, and 4 cards that consisted of 60% tin. The different tensions would be 9 N, 10 N, 11 N, and 12 N. The length for the solder would be ¼ in, 3/8 in, ½ in, and 5/8 in. This would give us a total of twelve cards each containing 96 wires. This would give us a total of 1152 samples.
(Card with wires)

In the process of making the 6% Au samples we ran into trouble making the cards. The wire kept braking after contacting the solder. Hans and I tried several times but had no success. We then went on to find out why the wire kept breaking. We thought maybe the wires were defective, so we tested them under tension. The wires did not break. I had noticed during my soldering training that the wire would break easily when it used a high setting on the soldering iron. I brought that point up to Hans and he then verified my results by pulling on the wire and the contacting the soldering iron with the wire. We did this several times and tracked our results in the figure 1. I then set up an apparatus to get better measurements on the initial results.

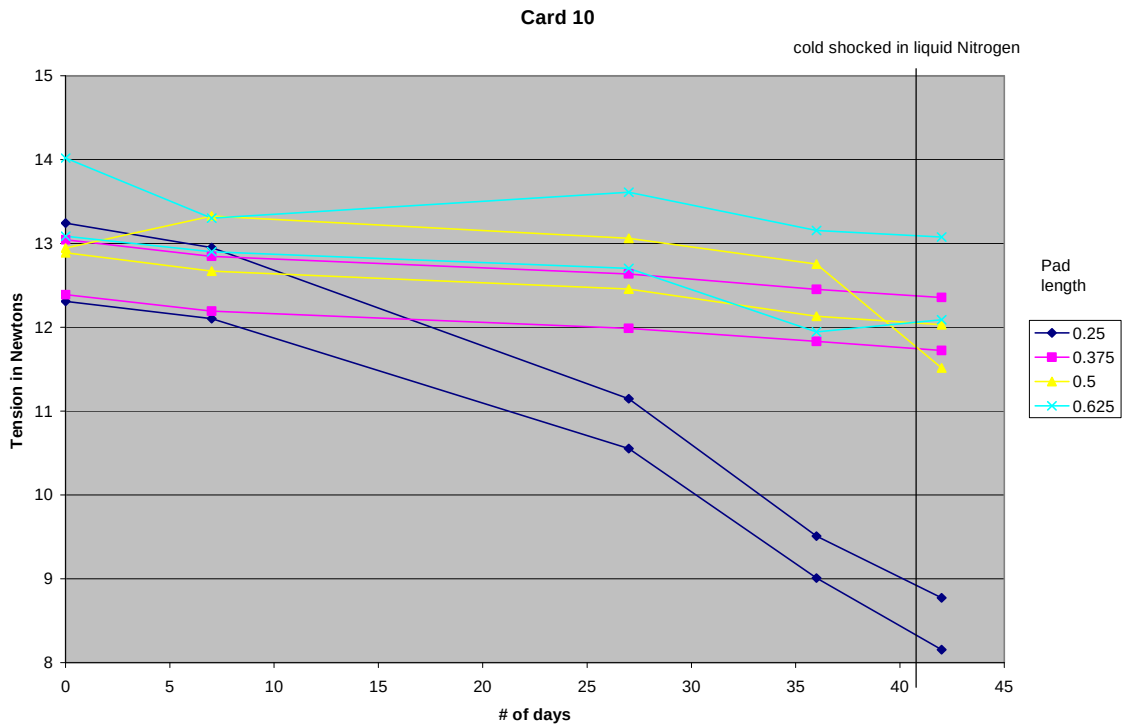
The first thing I did was to figure out what was the actual temperature for each setting on the iron. I did this in two ways using a thermocouple I measured the temperature at each setting. I did noticed that the temperature varied by about 20 degrees Fahrenheit. Then to simulate the temperature while the wire is inside the solder I wrapped the soldering tip in aluminum. This dropped the temperature change to 8 degrees Fahrenheit. Using the calibrated iron, a stop watch, a two pound weight, and a machine that would hold the weight I tested the theory that the wire was breaking due to the heat and not the tension.

The first step was to make sure the wire was not defective. I set up the 2 pound weight and let it hang for 24 hours. The wire did not break. I then touched the wire with the soldering iron at different temperatures with and with out solder and recorded the time it would take for the wire to break. My results are in figure 1. Based on the results it clearly shows that the wire breaks once the wire reaches a temperature of 650 degrees Fahrenheit. Unfortunately, this is the temperature required to make the silver solder flow smoothly to solder the wire. This means that we would not be able to make the cards containing silver in the solder.

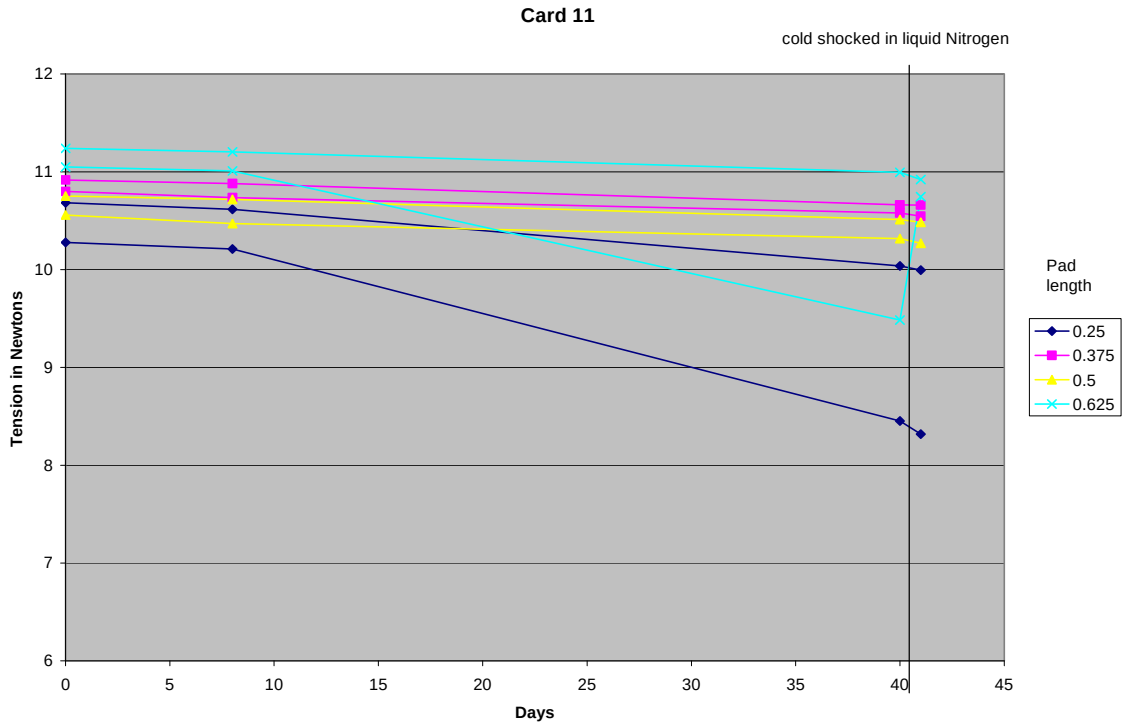
Figure 1.
Note: the wire at below 500 degrees did not fail in over 2 minutes.



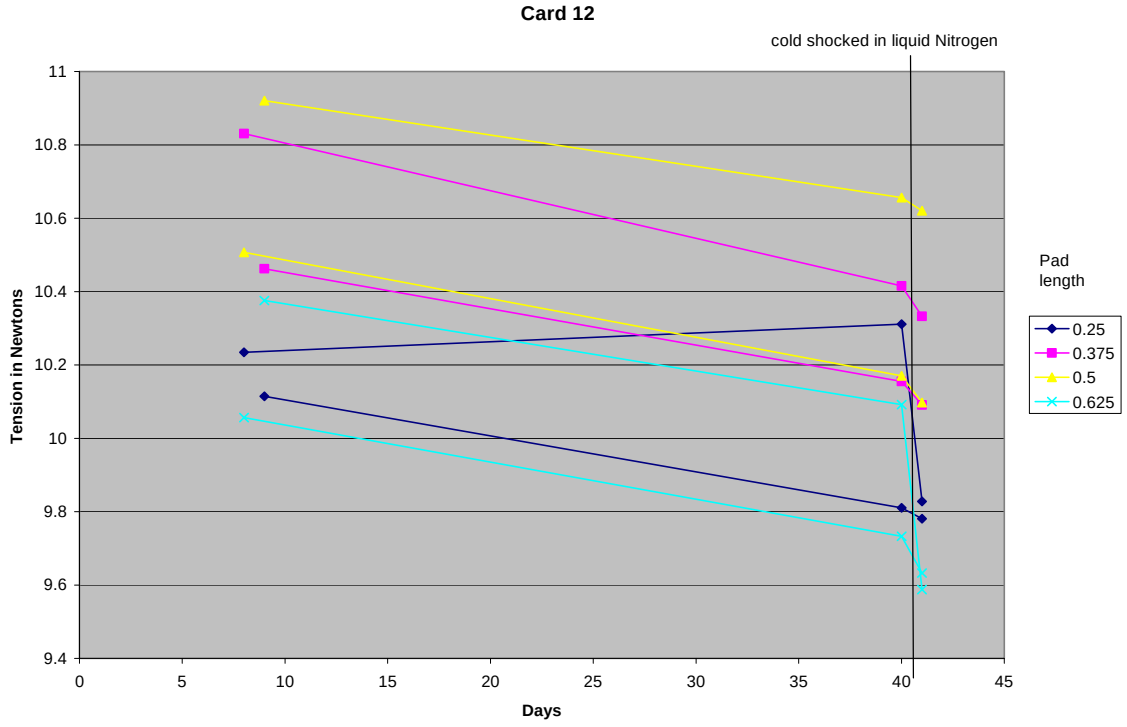
Due to the fact that we were unable to use the silver solder, Hans and I completed a total of seven cards using the 60% tin solder. The cards were going to test the loss of tension in the wires over time. The cards were will have different initial tension. Due to the fact that during assembly the wires had to be pushed to line up with the pad, the wires themselves had different initial tension with in the same card. The controlled part of the experiment was the pad length. The size of the pads was going to increment by one quarter approximately every 12 wires. This would allow us to see if the length of the solder joint affects the tension loss. The charts below show the results of the data as an average tension loss per length of joint over time. Note: on all the cards day zero is the day the first card was completed.



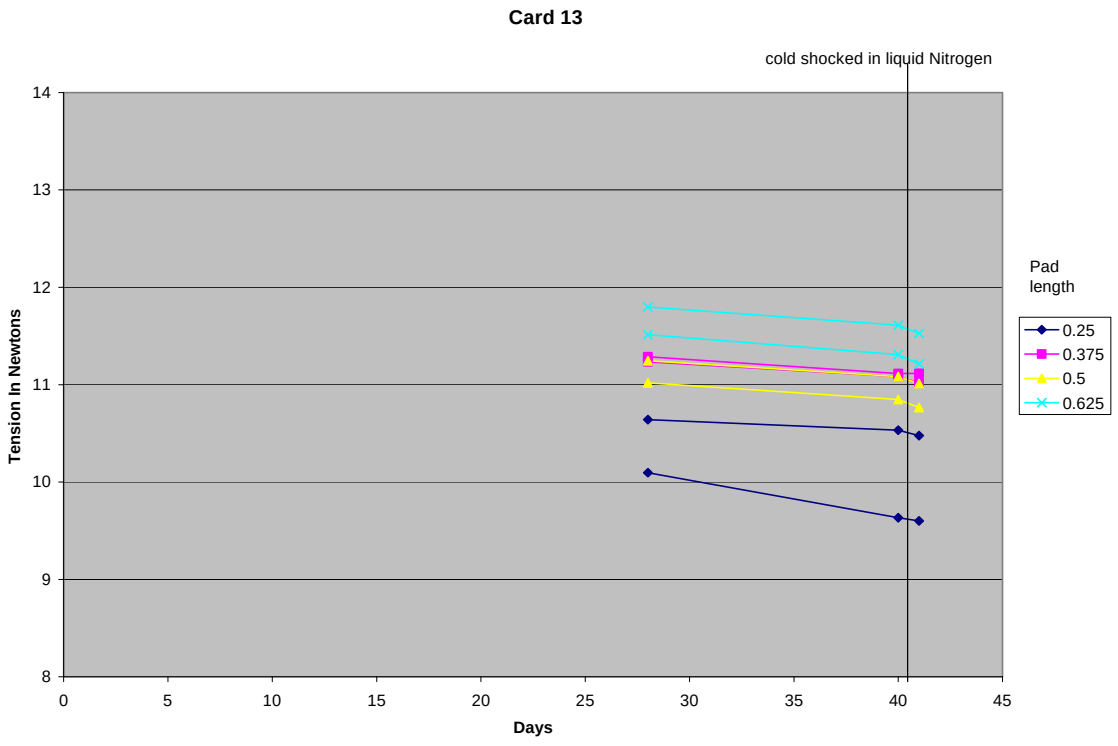
Card 10 had the longest life of all the cards. It shows that initially the tension loss is uniform in the first seven days. In the late days the longer solder joint seems to old better. Then when cold shocked the shorter solder joints is affected the most.

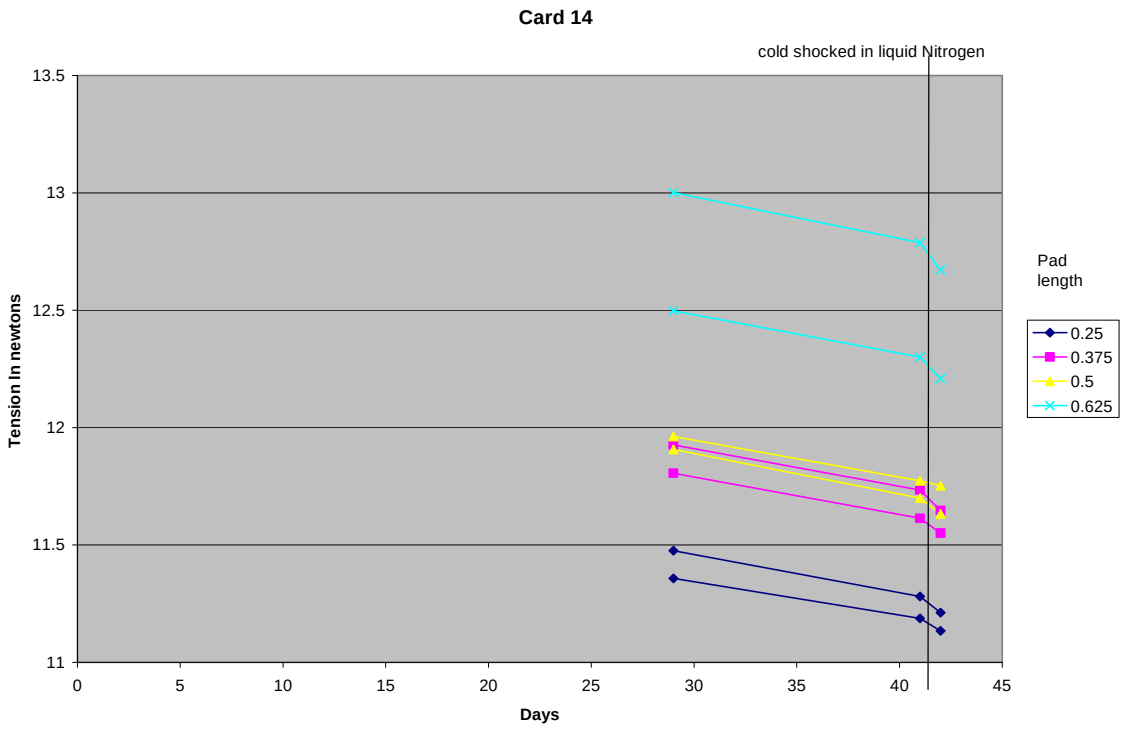


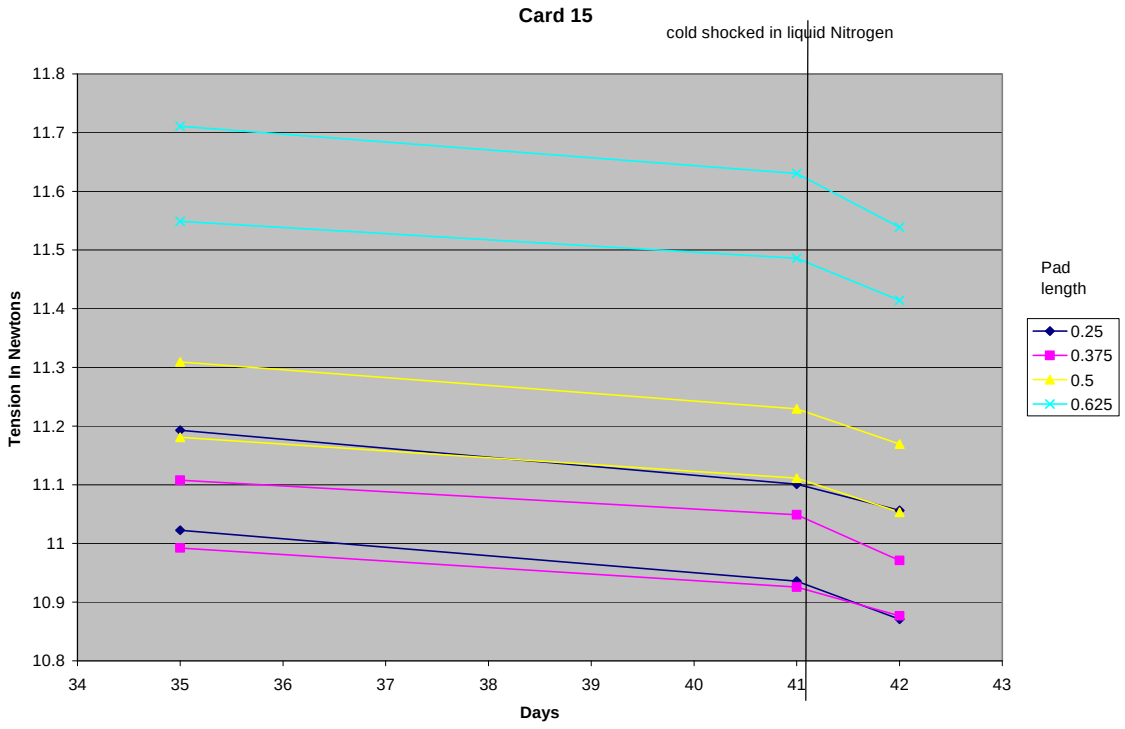
Card eleven seems to parallel the results in card ten.

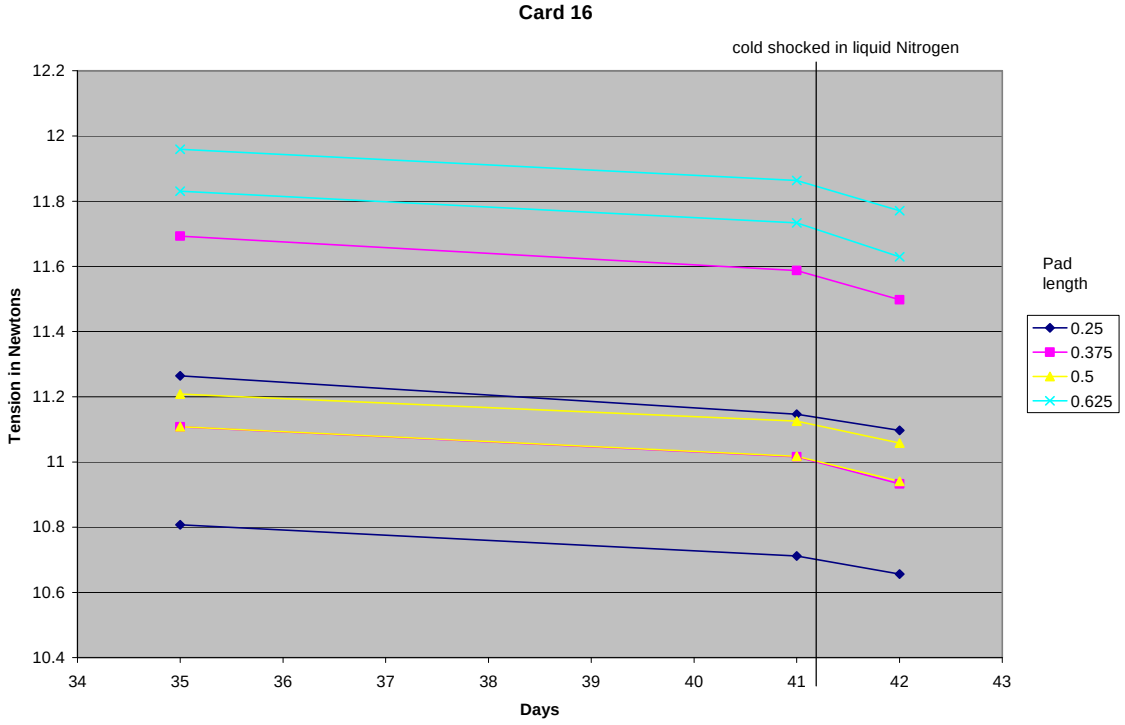


Card 12 shows a dramatic loss in tension after being cold shocked.


Card 13
cold shocked in liquid Nitrogen
Tension In Newtons
Days
Pad length
0.25
0.375
0.5
0.625


Card 14
cold shocked in liquid Nitrogen
Tension In newtons
Days
Pad length
0.25
0.375
0.5
0.625





Important side note is that all cards were cold shocked by submersing into can filled with liquid nitrogen. The cards were left in the nitrogen till the boiling affect slowed down which was an average of 3-4 seconds. The date of the shocking was August 13, 2008.