Colorado Space Grant Consortium

Exposing Nanofibers to Increased Radiation Flux

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1.0 Mission Statement

Our overall goal this flight is to examine the effect of increased radiation flux on carbon nanofibers. After this flight, we would like to confirm any findings via a future payload. In the end, our main objective is to be able to say with confidence that increasing radiation flux either does or does not have an effect on nanofibers based on a comparison with a control sample left on the ground. We'd also like to understand what that effect is.

2.0 Requirements Flow Down

Level 0

- The payload shall include an Onset Temperature HOBO Data Logger.
- The payload shall include an enclosure capable of sustaining and preserving the nanofibers, heating elements, and Hobo.

Level 1

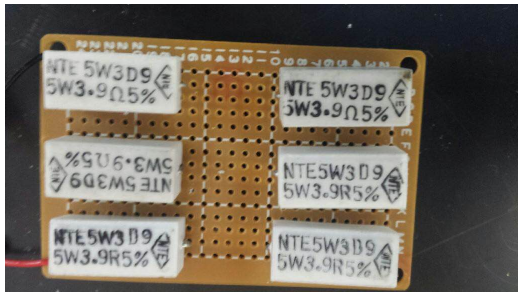
- The data logger is used to measure the temperature during the flight.
- The nanofibers are suspended in distilled water and will be tested after flight for the effects of increased radiation exposure.
- The nanofiber's test tube was tested at extreme temperatures and tested for durability to be sure it will not break during flight.
- The temperature will be regulated using heating elements, a Mylar blanket, foam core, and fiberglass insulation.

Level 2

- The box design was crafted to best fit nanofibers, heater and the data logger.
- The placement of items in the box was important to reduce g-forces during flight and landing.

3.0 Design

- Our box is pictured to the right.
- The nanofibers were in suspension in distilled water, which was held in a plastic test tube. The tube was surrounded by 2-inch thick foam tubing. The open ends of the tubing were sealed using hot glue so any leaks will be contained. The tube was also placed in a plastic bag in the event the tube exploded or leaked.
- A heater was used to try and ensure that the water did not freeze. The heater was constructed from batteries and resistors, is shown at the lower right.
- An HOBO Temperature Data Logger collected temperature data. Knowing the ambient temperature in the box gave us a good idea what was happening during the flight.



4.0 Budget

- Foam core and box materials - $30
- Test tubes - $50
- Hot glue - $10
- Insulation - $10
- Nanofibers - $250
- Heater materials - $40
- Data Logger - $200

Total = $590

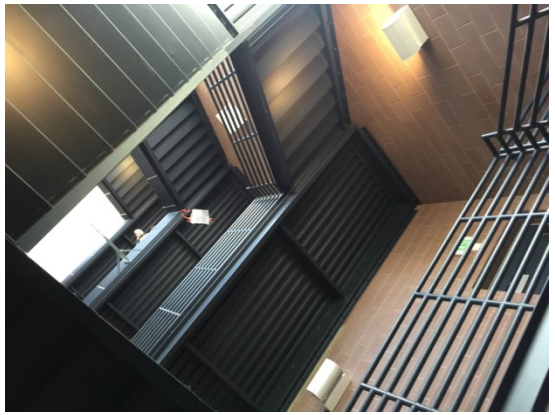
5.0 Management

- Amber Bekkali
  - Logistics, hardware, and assembly
- Ryan Fabian
  - Development of heating system
- Donovan Anderson
  - Hardware
- Anthony Saccomanno
  - He developed software for a Geiger counter. However, we will have to save this for the next launch due to weight restrictions.
- Patrick Peek
  - Final heating system

6.0 Tests

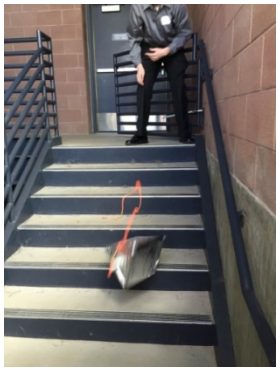
- Passed swing test
  - Box was forcefully swung for about 5 minutes.

- Passed drop test
  - Box was dropped from 4 stories.

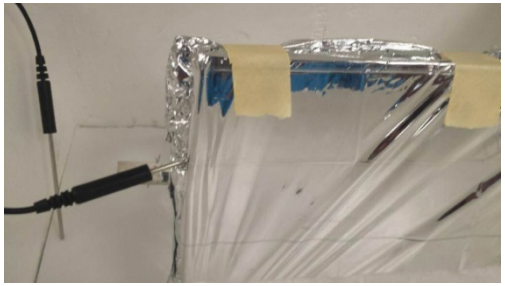


6.1 Tests continued

- Passed stair drop test
  - Box was tossed down 3 flights of stairs multiple times.



- Passed the heater test
  - Box was sealed and placed in liquid nitrogen to test heater and temperature (recorded data for 2 hours).



7.0 Expected Results

We expect that our box will be able to withstand the rigors of the flight and the forces of the landing. Our fluid in which the nanofibers are suspended will not freeze, which would cause any data to be subsequently collected to be invalid. Our payload will have a successful landing during which our nanofibers' test tube will not break. The heater will last the amount of time expected and keep the batteries, water, and hobo system adequately warm. We expect (based on research articles) to see some kind of change/effect (in comparison to a control sample) in the nanofibers as a result of the increased radiation flux from the flight.

8.0 Launch and Recovery

- The launch went smoothly. We were able to turn our heater on 20 minutes prior to launch.
- The payload was airborne for approximately 120 minutes.
- The recovery also went well. The box was in great condition with no noticeable damage to the exterior.

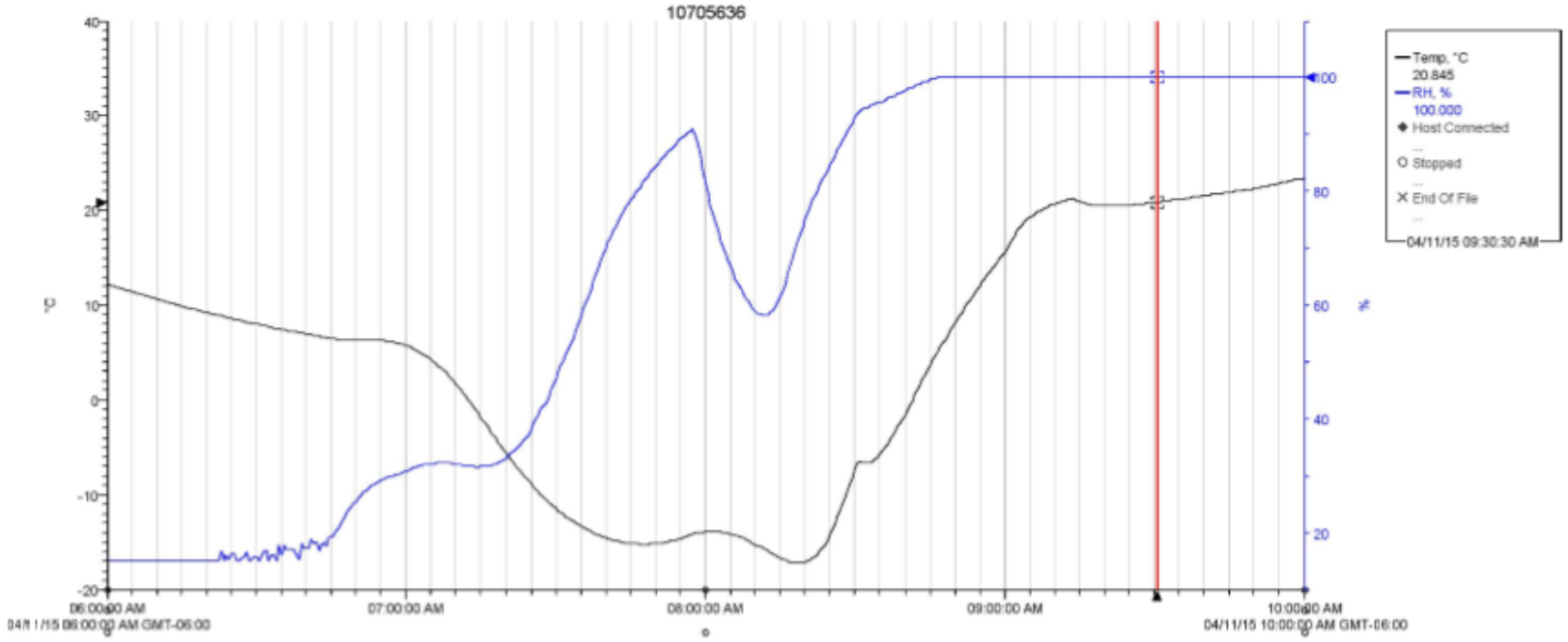
9.0 Results of Launch

- Unfortunately, our heating system failed to maintain a temperature above zero degrees Celsius, which caused our water to freeze and, subsequently, our vile broke.
- Due to these unfortunate events, we were not able to conduct any tests on the nanofibers.
- Payload structure worked perfectly.

9.1 Data Analysis

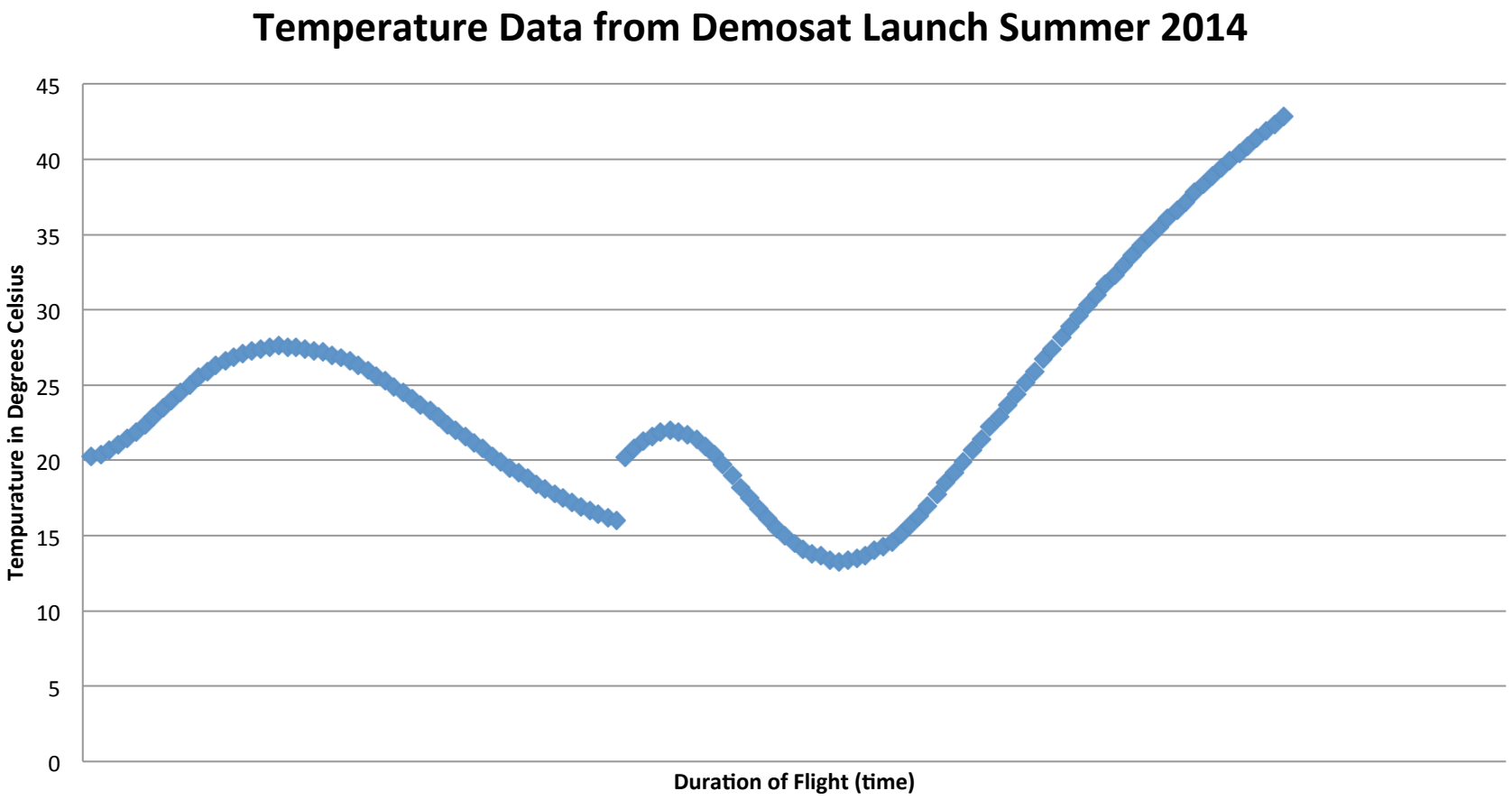
Temperature Data from Flight.

Obviously the temperature dropped below 0 degrees Celsius (graph is in Celsius) reaching around -20 Degrees Celcius. The dark blue line is temperature while the light blue is humidity. We are not sure why it is at 100% at the end of the flight.



9.1 Data Analysis Continued

We do not understand why the heater system did not work this time around but it worked very well during the flight of summer 2014.



10.0 Conclusion

As a result of our heater not being able to maintain a temperature above freezing, we were not able to test the nanofiber sample. We are still not certain as to why our heating system did not function properly, as all of our post flight test's have still been successful, but we will continue to work on this design to ensure that we do not run into similar issues in the future. Even with this failure, we successfully secured our sample in a manner that kept it from being damaged during the flight. Also, our level of redundancy allowed us to contain the sample after the vile failed. Although we experienced a major failure, this process has pushed us forward in a manner that will allow us to be successful in the future.

10.1 Lessons Learned

While we were not able to conduct any tests on the affects of radiation on our nanofibers, we still gained a wealth of knowledge in regards to the handling and imaging/measurement of nanofibers. With this new knowledge, we will be better prepared to conduct a more thorough examination of the radiation affects on carbon nanofibers on a later flight.

11.0 Message to Next Year

Overall, our experience was positive as we learned very much. However, due to the vial breaking during the flight, we could not proceed with testing the nanofiber sample as we had planned. We would encourage more careful testing of various ways to contain the nanofibers given the extreme conditions encountered during flight. In this way, unexpected failures such as we had we our heater can be more effectively dealt with. We tested the sample's tube in a vacuum, at extreme low temperatures, and while doing the drop tests, but the tube still did not withstand the actual flight as our testing did not account for a heater failure (and the suspension fluid freezing). Our box, itself, was a success. Our team did great with delegating responsibilities this flight, but I would recommend adhering to deadlines better to be more successful.