NASA ISGC: Cryo- Tensile Testing Load Frame (cont.)

Contacts: Dr. Matthew Swenson, Dr. Michael Maughan

Background:

The contacts above have initiated a research collaboration with NASA engineers at the Marshall Space Flight Center (MSFC) involving testing mechanical properties of materials at cryogenic temperatures approaching 100 K. To do this, we have embarked on designing and building our own load frame to accomplish this testing capability. This past academic year, a capstone design team found an old load frame on campus and designed and built alternations to the load frame to accomplish cryogenic testing. In the process, they successfully engaged an expert at the National Institute of Standards and Technology (NIST), so we have high confidence in the direction take by the team. They did a great job with the design and prototyping (Fig. 1) and delivered a compelling presentation at the 2022 EXPO.

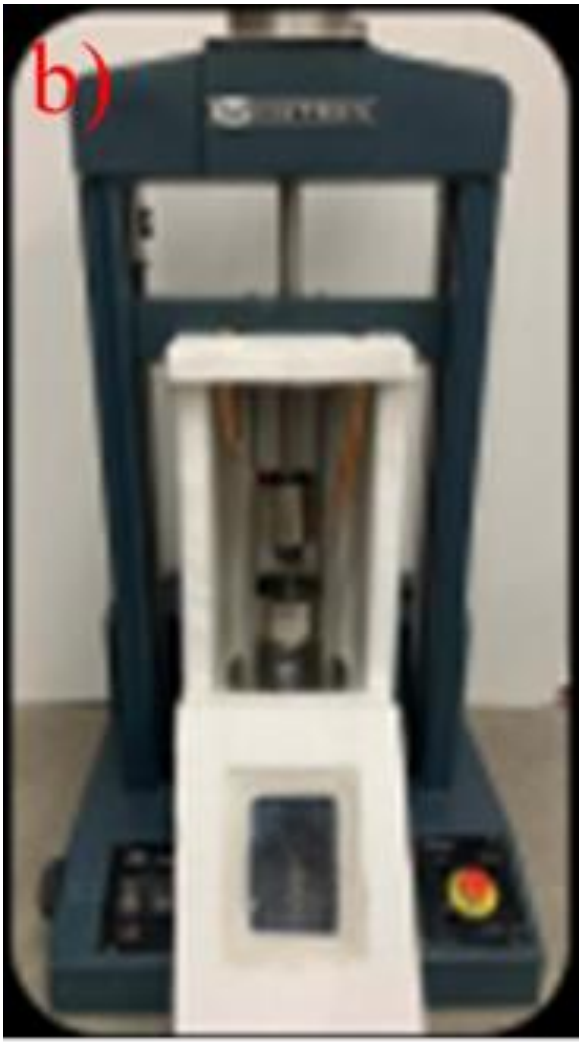

Figure 1. Image of the load frame with cryogenic system and insulation installed.

As with many projects involving this level of sophistication, this initiative was always planned as a two-project sequence. This second capstone project is designed to continue this great work and help with resolving any unresolved issues with the device to make it fully operational and "research ready."

Objective:

The purpose of the project is to continue with the existing design and prototype load frame and resolve several major functionality issues to make the design ready for conducting research.

Deliverables:

It is desired for the following open items to be addressed with the design:

1. Calibrate the load cell
2. Reduce the motor speed
    a. The motor cannot move slow enough with the available gear configuration
    b. A possible solution is to order and install a VFD (variable frequency device) for motor speed control bypassing the gearing issue.
3. Ensure the motor will not stall during testing
    a. The motor is unable to break anything stronger than a plastic sample.
    b. The motor stalls out when presented with a 6061 Al sample.
4. Improve the insulation around the test chamber.
    a. The current enclosure solution does not adequately insulate the sample.
    b. The lowest achieved temp was 125 K, while the target is 100 K
5. Design a control system for control the sample temperature at intermediate temperatures
    a. There is currently no solution to maintaining a temperature other than room temp and 100K.
    b. Design and fabricate heating system.
    c. Use thermocouples for feedback to a controller
6. Evaluate and improve the Windows-based Control system
7. Verify and troubleshoot the extensometer and load cell, ensuring the measurement systems are properly calibrated and accurate.

Budget:

The budget for the project will be ~$1000. More money can be available if the project can justify it.