A Tribometer in Space-like Conditions

Team 501: Madison Retherford, Cobi Johnson, Branham Channell, Javier Ibanez, Joshua Wesley

FAMU-FSU Engineering

3M Science. Applied to Life.™

Objective

The objective of this project is to design, develop, and implement a system that enables the **simultaneous testing of multiple samples within a vacuum chamber using a tribometer**.

Motivation

- Takes **over 12 hours to reach high vacuum** (10^{-6} mbar).
- **Current solution tests only one sample at a time**.
- There is a need **to test 4-6 samples simultaneously** with the ability to use different inputs on different samples.

System Needs to

- **Accept user inputs** for testing parameters and adjust them as needed.
- Continuously **measure parameters**.
- **Regulate** working temperature.
- **Measure** load cell.
- **Calculate** tribological quantities such as **coefficient of friction, wear volume, and wear rate**.
- Check safety requirements and **trigger an emergency stop if needed**.
- **Display** the calculations and sensor readings **using the AME's existing GUI in MATLAB**.

Selected Concept

Six Mini Tribometers
The six mini tribometers (Figure 1) will **be three to a row placed back-to-back**. They are like the current design but scaled down to fit inside of the vacuum chamber together.

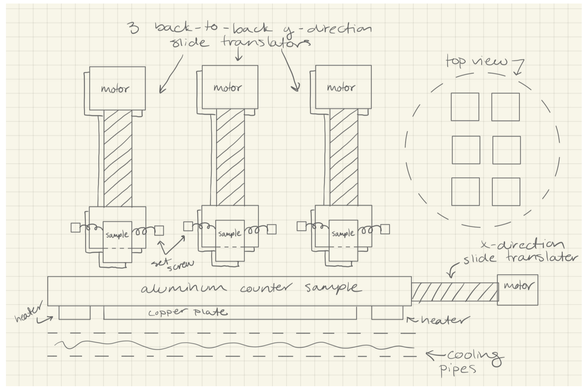


Figure 1

Design Challenges

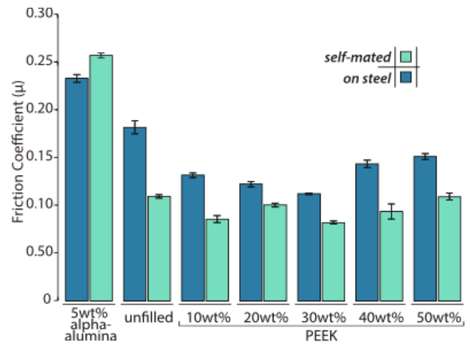
- **Scale of the tribometers** to fit six inside the chamber.
  - Approximately 2 ft. x 2 ft. cylinder.
- Space for the operator to **change out samples.**
  - How **quickly and easily** this will be able to get done.
- Ensuring **no cross contamination** in such a small work area.
- **Wiring** of electrical components and ensuring **GUI compatibility** will take a substantial amount of time.

MATLAB Calculations

The **coefficient of friction (μ)** is obtained by **dividing the frictional force by the applied normal force.**

The **wear volume** $\Delta V = Vi - Vf$ where Vi is the initial volume of the sample and Vf is the final volume of the sample. The system will calculate real time data for meaning Vf updates constantly.

The **wear rate** $K = \Delta V / FnD$ where ΔV is the change in volume of the sample, Fn is the normal force and D is the displacement.



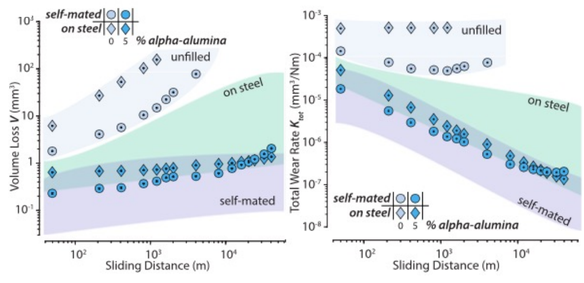


Figure 2, Macromolecules 2022, 55, 3924−3935

CAD Design Prototype

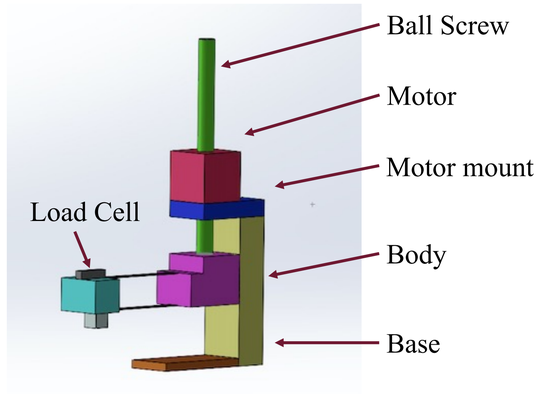


Figure 4

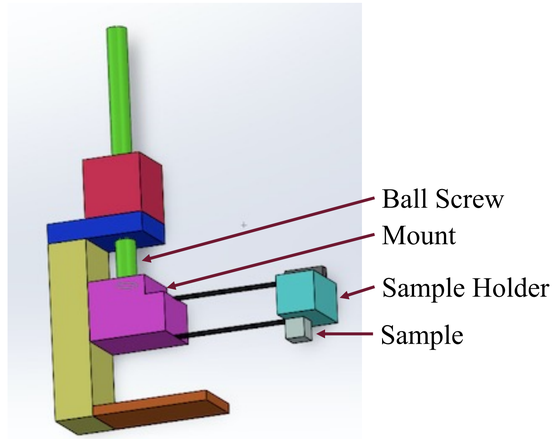


Figure 5

Future Work

- **Develop** and produce an assembly to **optimize** the leaf spring and load cell.
- **Determine mounting points** in the vacuum chamber.
- **Finalize** the CAD model.
- **Simulate** the CAD functioning under spacelike conditions.