# Switchable Adhesives for Space Applications

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## Research Overview

**Research Question:** Can we develop a switchable adhesive that works consistently and controllably in space?

**Background:**

- The International Space Station uses robotic arms for maintenance.
- Many connections and arrangements available → Versatile maintenance device.
- Switchable adhesives→ consistent, controlled attachment mechanism
- Testing in pressure vacuum and ~ +/- 150°C

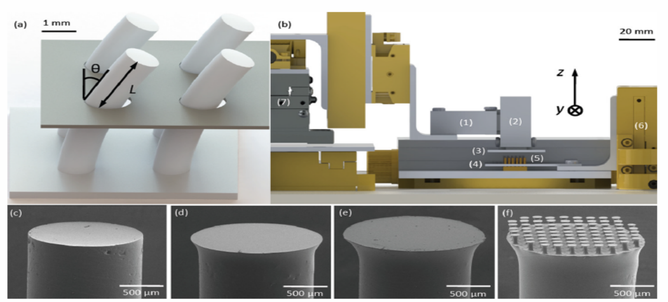


Figure 1: General trial for friction/ adhesion characterization devices. [1]

## Switchable Adhesives

### Major inspiration:

- Gecko feet→ hierarchical structure + biomechanics

### Current Applications:

- Locomotion on smooth surfaces
- Pick and place

### Current Switchable Mechanisms:

- Pre-compressive buckling
- Reduction of contact area
  - Mesh design [1]
  - Specified gripping/ releasing direction→ triangles [2]
  - Magnetic field and cantilever beam control [3]

References:
[1] Marvi, H., Y. Han, and M. Sitti. "Actively Controlled Fibrillar Friction Surfaces." *Appl. Phys. Lett. Applied Physics Letters* 106.5 (2015): 051602. Web.
[2] Jin, Kejia, et al. "Biomimetic bidirectional switchable adhesive inspired by the gecko." *Advanced Functional Materials* 24.5 (2014): 574-579.
[3] Northen, M. T., Greiner, C., Arzt, E. and Turner, K. L. (2008), A Gecko-Inspired Reversible Adhesive. Adv. Mater., 20: 3905–3909.
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## Experimental Setup

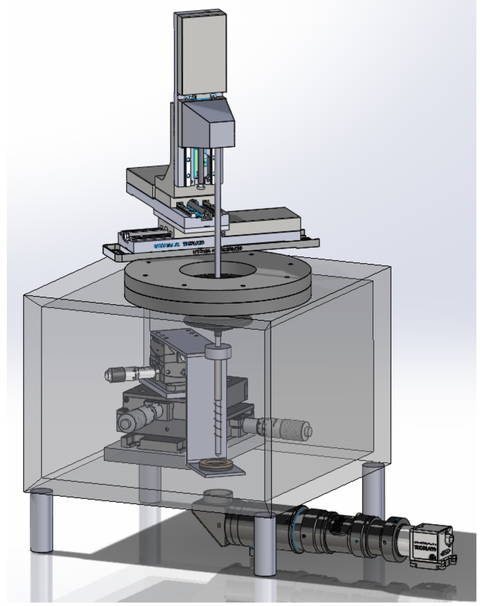

Figure 2: Solidworks model for the entire setup.

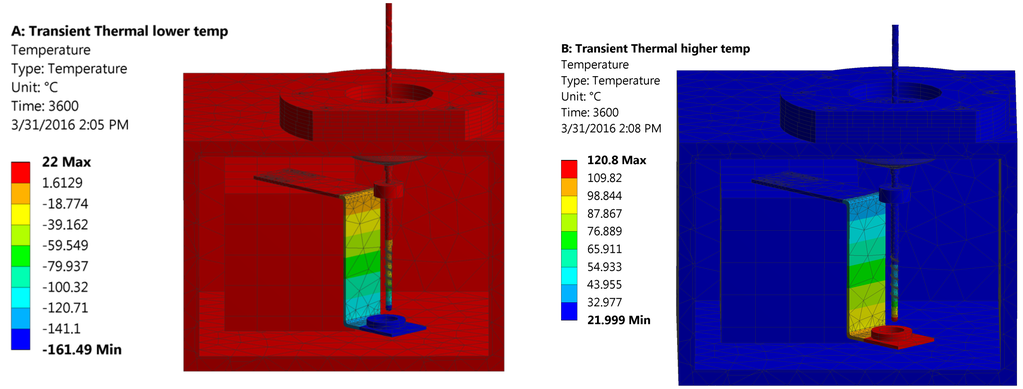


Figure 3: Thermal analysis of internal components at lower limit ~-160°C (left) and upper limit ~120°C for temperature.

### Other Analysis and Considerations:

- Finite Element Analysis (FEA) for chamber under vacuum
- Temperature monitoring
- Heating and cooling stage
- Load cell in vacuum environment

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