College of Engineering
LAMAR UNIVERSITY

MISSE – Fly

Introduction

The Materials International Space Station Experiment (MISSE) is a series of missions that test the durability and performance of materials and devices by exposing them to the harsh conditions of space on the exterior of the International Space Station (ISS). Our team is collaborating with other universities which are Texas A&M, West Texas A&M university, and Prairie View A&M university, Florida A&M. The company that will take our samples to the ISS is Aegis Aerospace. Launch will be no earlier than October 19,2025. Installation later in Fall 2025, Retrieval June 2026, and Finally De-integration(the process of taking apart the sample holders and analyzing the returned materials) in July 2026.

Problem statement: The team will study the effects of a 6-month space exposure on the mechanical properties of smart-skin samples for the NASA MISSE mission, using dosimetry films to monitor radiation levels. Samples will be arranged in shielded, multi-layer arrays to allow controlled radiation exposure and enable pre- and post-exposure mechanical testing.

Statistical Methods

Testing will be performed on the samples when they return to Earth to determine the effects of radiation and LEO orbit on the mechanical properties of the silicone. The team has designed two-sided t-tests to determine if the elastic modulus and tensile strength of the silicone will fall within hypothesized ranges for each sample. Mechanical testing will also incorporate qualitative observations that we will be used to measure physical changes in the silicone after LEO.

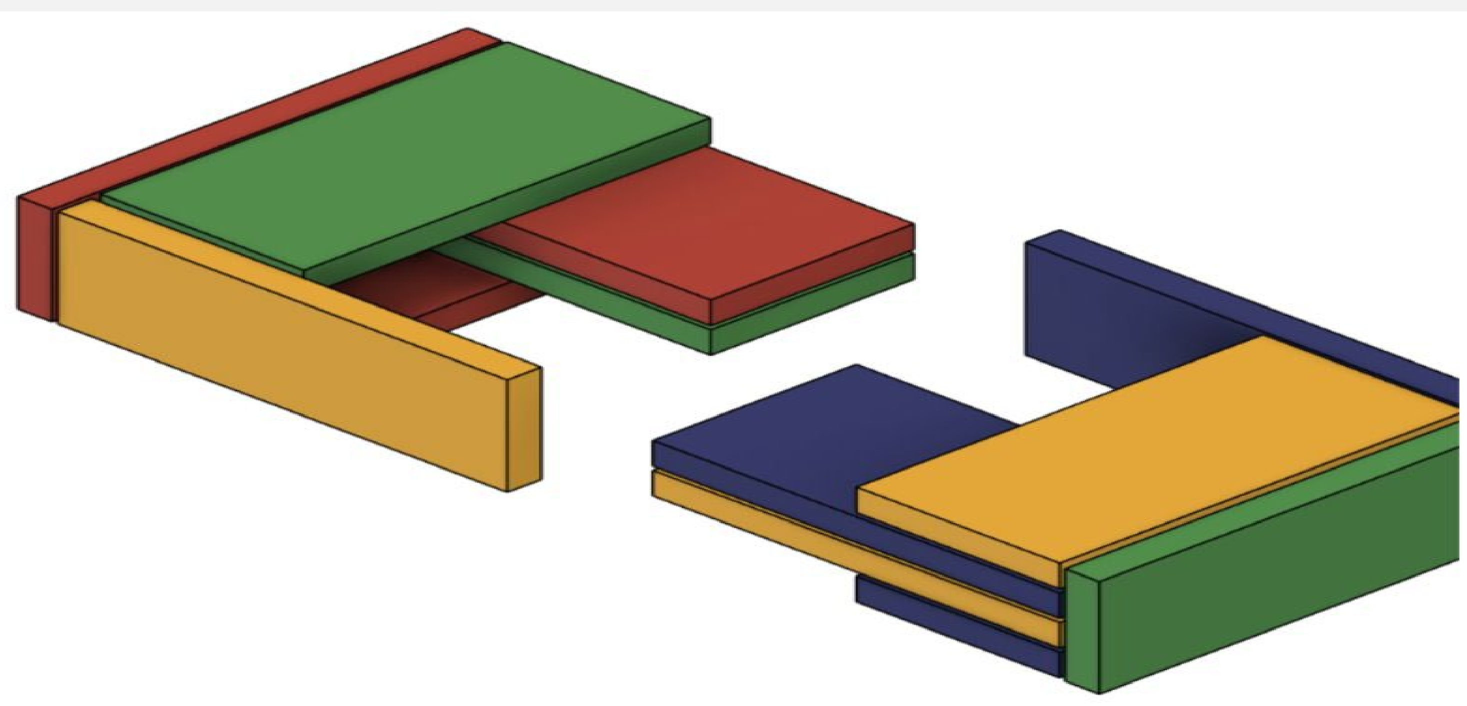
Experimental Overview

Group	Bismuth %	Sample Size (n)	Elastic Modulus Predicted Range (lbF/in²)	Tensile Strength Predicted Range (lbF/in²)
Control	0%	3	10–10.5	11–11.5
A	5%	3	10.8–11.2	11.8–12.2
B	15%	3	12–12.5	13–13.5
C	30%	3	15–15.5	16–16.5

Dog-bone samples of silicone

Sample Orientation

The sample stack will have alternating layers of the silicone composite and dosimeter film. The stack will begin with a layer of dosimeter film. You're looking at the CAD model of the sample stack that will be delivered to Aegis for orbit. Blue is the pure silicone control, green is silicone with 5wt% bismuth nanoparticles, yellow has 15wt% bismuth, and red has 30wt% bismuth. The purpose behind this orientation was to ensure that all the samples receive relatively the same levels of radiation. With the uncertainty of space, and the difficulty of tracking radiation, this will be the best orientation for the samples.

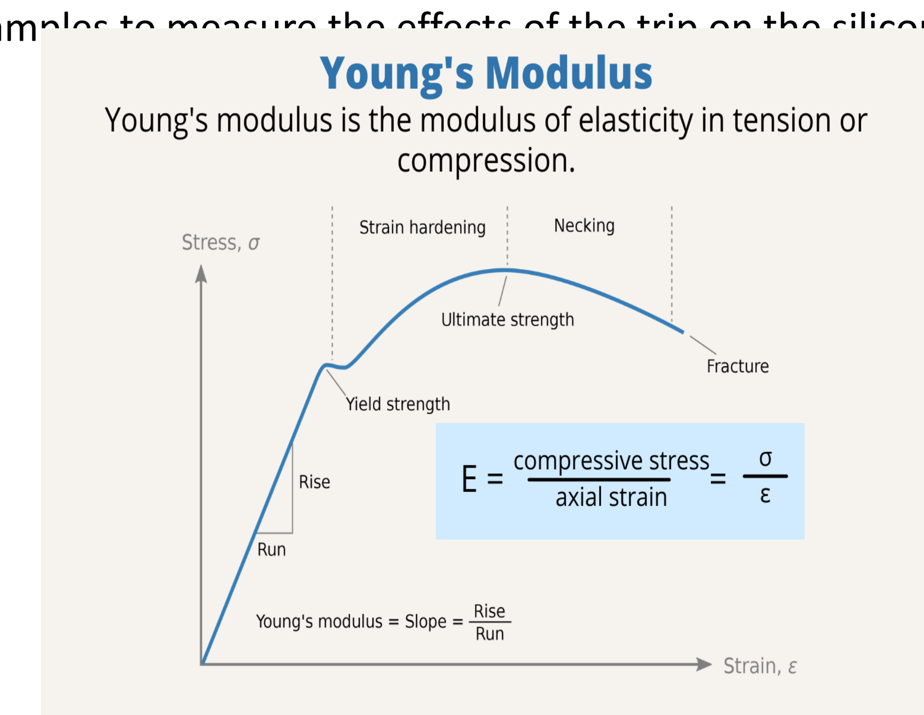


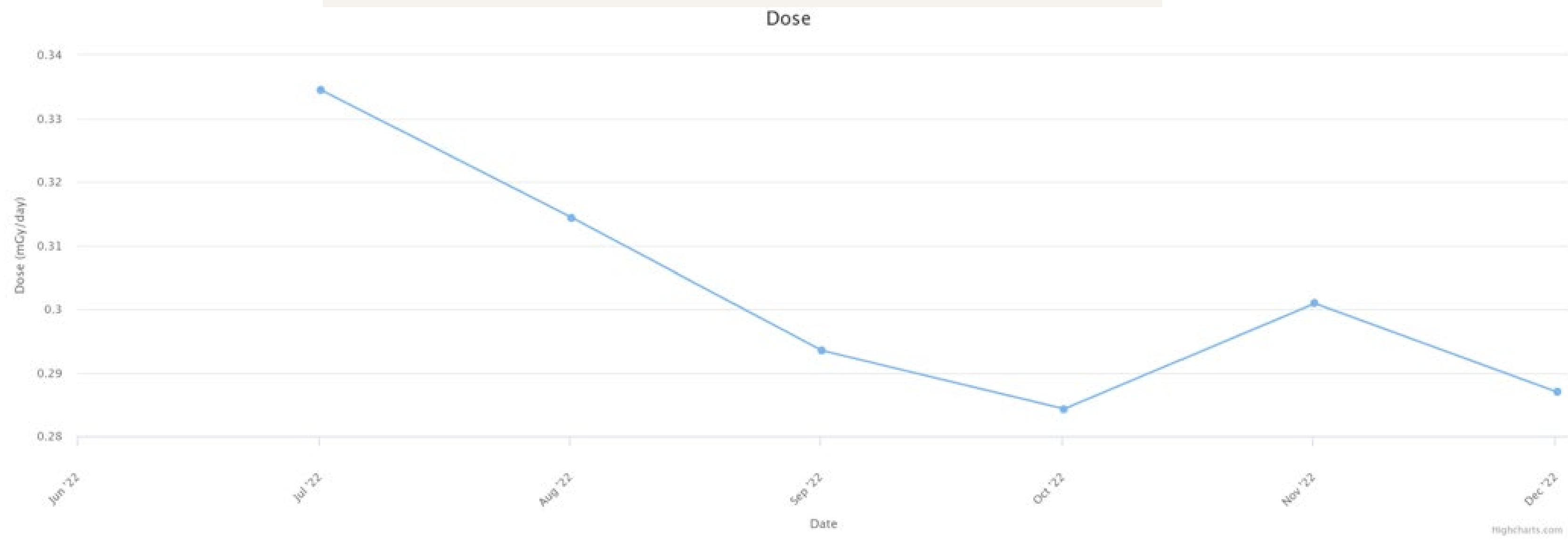
Low Earth Orbit and the ISS

Low Earth Orbit (LEO) experiences extreme temperature fluctuations, ranging from -250° F (-157° C) in the shadow of Earth to over 250° F (121° C) when exposed to direct sunlight. Low Earth Orbit (LEO) is the closest orbital region to Earth's surface where satellites operate. Though it lacks a strict boundary, LEO is generally defined as extending from 160 to 1,600 km (100 to 1,000 miles) above Earth. The International Space Station (ISS) orbits at an altitude of 400 km (249 miles), moving at a velocity of approximately 7.8 km (4.8 miles) per second. At this speed, the ISS completes an orbit in just over 90 minutes, allowing it to circle Earth around 16 times per day. Being in a thin part of Earth's atmosphere means that objects in LEO rely on radiation for heat transfer, making thermal control a critical aspect of spacecraft design. Additionally, LEO is subjected to intense radiation from the Sun and cosmic sources, which can degrade materials and electronics over time.

Young's modulus, also known as the elastic modulus, quantifies a material's resistance to elastic deformation under applied stress. It is mathematically expressed as the ratio of normal stress (force per unit area) to corresponding strain (relative elongation or compression) within the linear elastic regime of the stress-strain curve. A material exhibiting a higher Young's modulus demonstrates increased rigidity, signifying reduced deformation under external pressure, making it a critical parameter in structural and materials engineering for assessing mechanical performance and stability.

Young's Modulus will be used to test the effects of the Low Earth Orbit space environment on the sample. It also helps predict the effects of the environment on the sample before it is sent to space. Qualitative data of the smart skin, such as color and weight, will be recorded before it is sent to orbit. Gafcromic HD-V2 radiation film will be utilized to measure the radiation dose of the sample. The expected radiation dose is simulated using OLTARIS. Post-orbit testing will be conducted on the samples to measure the effects of the trip on the silicone.





MISSE Science Carrier

MISSE relies on highly specialized infrastructure aboard the ISS. Our samples will be Stowed in the MISSE Science Carrier, placed in external exposure racks, which are mounted outside the ISS. This unique setup allows us to simulate space conditions that are impossible to fully recreate on Earth, making the ISS an essential platform for advancing material science and testing long-term space durability.

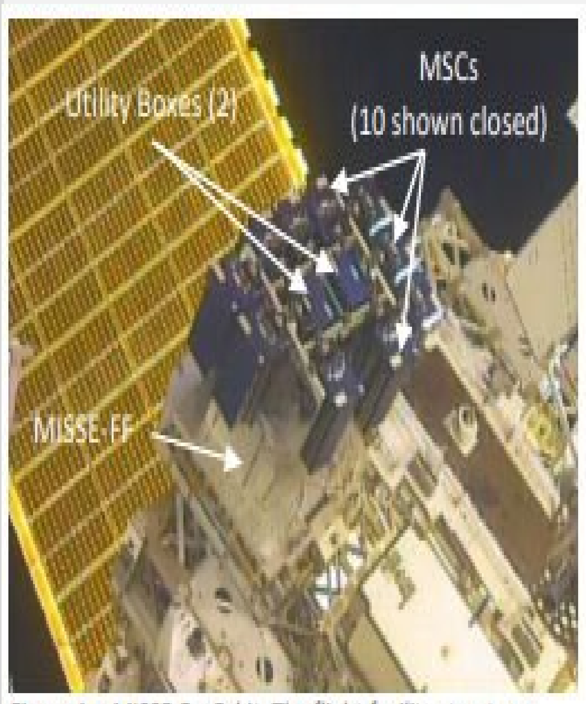


Figure 1a: MISSE On Orbit. The flight facility structure (white) supports two utility boxes (blue in middle) and up to 12 interchangeable MSCs (blue, sides, shown closed).

Figure 1b: MISSE On Orbit. View of nadir face (right; on nadir MSC slot is unoccupied) and ram face (left side of image). All MSCs are opened.

Students & Faculty Mentors

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