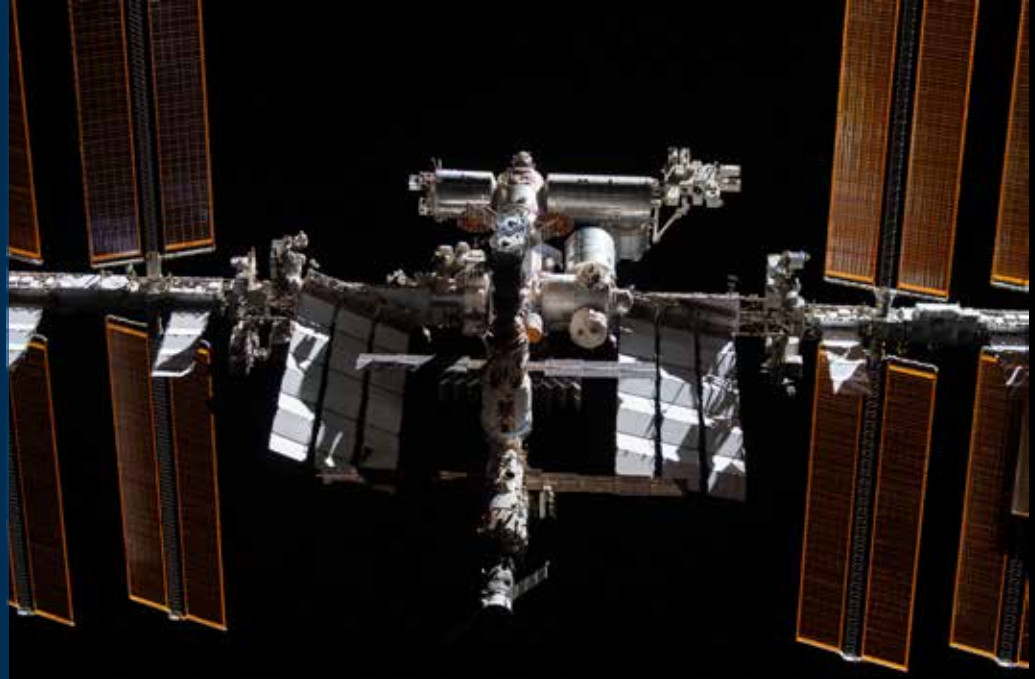
NASA astronaut Dan Burbank, Expedition 30 commander, conducts a session with the Preliminary Advanced Colloids Experiment (PACE) at the Light Microscopy Module (LMM) in the Fluids Integrated Rack / Fluids Combustion Facility (FIR/FCF). Image Courtesy: NASA

USRA Universities Space Research Association

LOW GRAVITY SCIENCES

Advancing Human Spaceflight

USRA microgravity research began in 1997 with a partnership with NASA's Glenn Research Center and Case Western Reserve University. USRA brings deep expertise in microgravity science operations across the International Space Station and orbital and suborbital platforms through cutting-edge combustion and fluid physics research. Our teams conduct human spaceflight investigations, including engineering assessments that inform the design of future medical systems, and analyze filtration systems returned from the ISS to guide next-generation life support improvements. Through close collaboration with NASA's Glenn Research Center, USRA advances key Artemis exploration goals. We also integrate data analytics and mission operations to ensure rigorous execution, strengthen validation, and deliver actionable insights for sustained performance in space environments.



The International Space Station is pictured from the SpaceX Crew Dragon Endeavour during a fly around of the orbiting lab in 2021. Image Courtesy: NASA/Thomas Pesquet

Enhancing Materials and Analysis Capabilities for Aerospace Systems

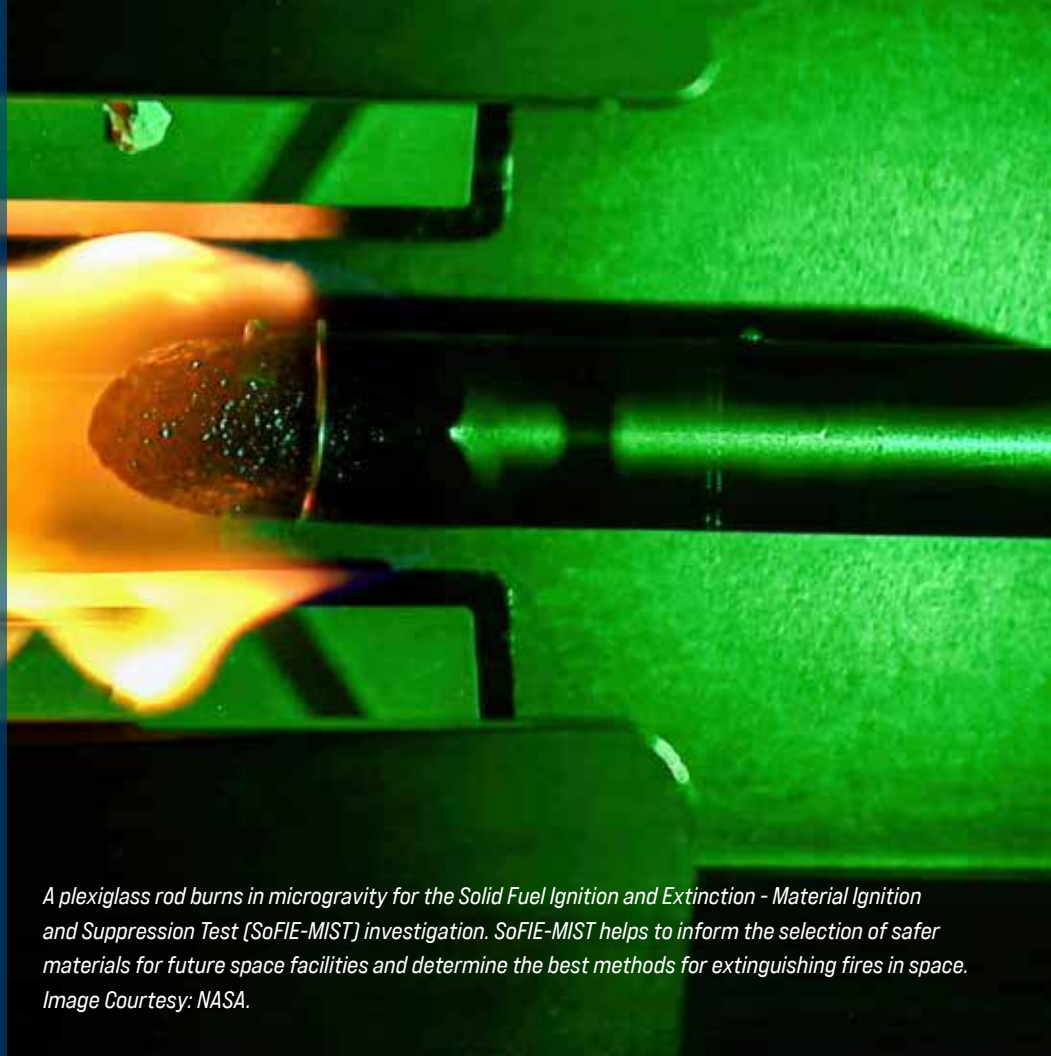
Our polymer aerogels and composites provide lightweight, high-performance thermal insulation for demanding applications. High-temperature polymers support electric aircraft and space power systems. We offer comprehensive characterization—thermal, dielectric, microscopy, and rheology—to validate material properties and performance. Our structural analysis integrates finite element modeling, experimental mechanics, and impact testing to inform design decisions. We also develop sustainable materials, including bio-based composites and nanomaterials, using environmentally responsible processes. For extreme environments, we engineer ceramic/polymer composites, thin films, and electronics suited to space and advanced aviation, enabling reliable operation under thermal, mechanical, and radiation stress while supporting efficient system integration.

Solid Oxide Fuel Ignition Extinction Research

The flame's appearance differs significantly from what we observe on Earth because the absence of gravity aboard the Space Station prevents it from forming the familiar shape. The flame's spherical structure results from combustion in microgravity, where buoyancy-driven convection does not occur.

How Does Fire Behave in Microgravity?

USRA is essential in NASA's Solid Fuel Ignition and Extinction (SoFIE) project through the Material Ignition and Suppression Test (MIST), a groundbreaking investigation conducted aboard the International Space Station. By studying how flames behave in microgravity, MIST provides unprecedented insight into realistic fire scenarios in crewed spacecraft. These discoveries not only strengthen fire safety strategies for future space missions but also advance terrestrial fire science.



A plexiglass rod burns in microgravity for the Solid Fuel Ignition and Extinction - Material Ignition and Suppression Test (SoFIE-MIST) investigation. SoFIE-MIST helps to inform the selection of safer materials for future space facilities and determine the best methods for extinguishing fires in space. Image Courtesy: NASA.