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Can provide data to enable manufacturing of long-life reliable components.

Extrême conditions occur in the space environment, including exposure to heat and cold cycling, ultra-vacuum, atomic oxygen, and high-energy radiation. Testing and qualification of materials exposed simultaneously to these extreme conditions provide data to enable the manufacturing of satellites and long-life reliable components used on Earth. The International Space Station U.S. National Laboratory provides an ideal environment for such materials science initiatives. Moreover, as with experiments in other fields, the space environment also offers unparalleled capability to study and measure processes with accuracy and precision not achievable on Earth.

Features of space science

Effects of microgravity:

- ▶ Loss of thermal convection, sedimentation, buoyancy, hydrostatic pressure and certain gradients.

Easier in space:

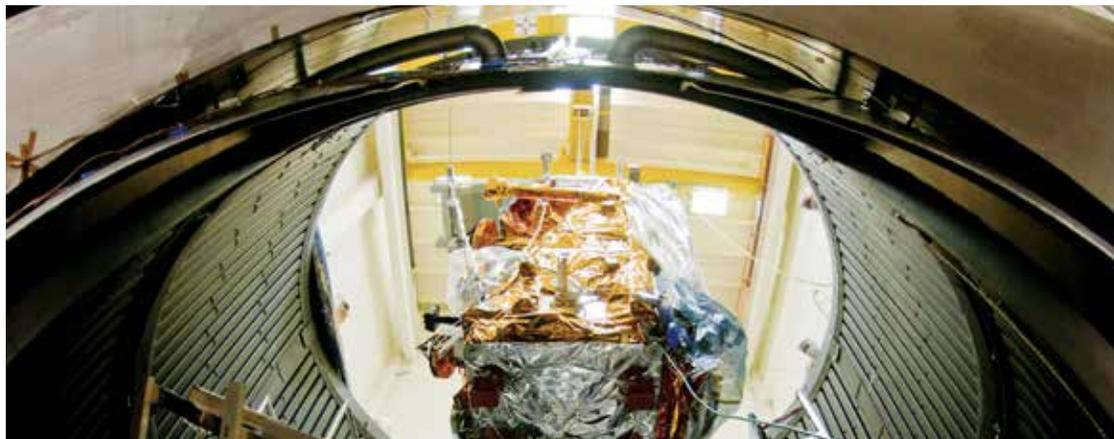
- ▶ Controlled conditions allow greater precision in the production of materials (such as organic/inorganic crystals, functional nanomaterials and advanced alloys).

Novel in the space environment:

- ▶ High and ultra-high vacuum, super-high-temperature synthesis (up to 3000K), temperature cycling, atomic oxygen and high-energy radiation.



RESEARCHER'S FACT SHEET: *Materials Science*



ISS photos courtesy of NASA.

Exploiting space-specific phenomena

- ▶ Test how materials behave in the external environment of the space station, including simultaneous exposure to a variety of extreme conditions.
- ▶ Optimize and develop materials for ground applications.
- ▶ Achieve cleaner results from experiments commonly compromised by trace molecular species or hampered by operating temperature limitations.
- ▶ Measure critical thermophysical properties not otherwise accessible for this type of analysis.
- ▶ Achieve even distribution of particles in solid-liquid mixtures.
- ▶ Study the behavior of matter near critical phase transition, granular material behavior and subsurface geotechnics.

Relevance & potential market applications

- ▶ Pharmaceutical and medical treatment design.
- ▶ High-efficiency catalyst production.
- ▶ Development of improved alloys and materials properties (at reduced development costs) based on measurement of thermophysical properties and the study of coarsening in solid-liquid mixtures.
- ▶ Design of materials, including satellite components, to withstand extreme conditions on Earth or in space.
- ▶ Improved insight into fundamental physics and materials science based on how materials behave when exposed to the extreme conditions of the space environment.
- ▶ Commercial process enhancement regarding large semiconductor crystals and nanomaterials for catalyst development, based on crystallization of nonbiological materials.

Note: For more information on the advantages of space-based experiments in fluid physics and its relevance to materials design, see the Physical Sciences Fact Sheet in this series.

To learn more, contact CASIS: info@iss-casis.org



The Center for the Advancement of Science in Space (CASIS) manages the International Space Station U.S. National Laboratory, supporting space-based research that seeks to improve life on Earth. The National Lab is now open for use by the broad scientific community—and CASIS is the gateway to this powerful in-orbit research platform. For more information, visit www.iss-casis.org.

For information on specific experiments in space, including resulting publications and patents, scan the code to your left.