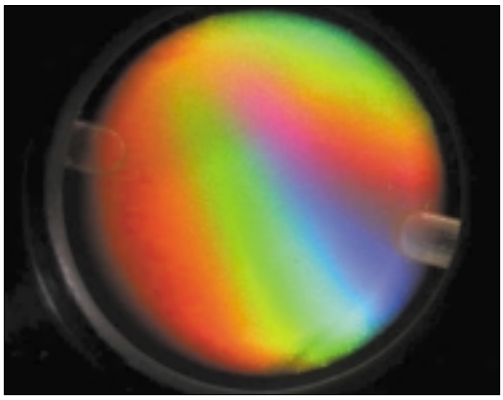
Microgravity and space processes

Space-based research is poised at a unique juncture—the construction of the International Space Station (ISS) is well under way, a reorganization of the microgravity office has occurred at NASA, and a reprioritization of microgravity science objectives through the Maximization and Prioritization (ReMaP) Task Force recommendations is in the works.



The AB6 binary colloidal crystal alloy showed crystallization while on orbit. The colored regions result from refraction of the white light used to illuminate the sample.

These changes will chart the future course of research in the Office of Biological and Physical Research (OBPR), and are likely to influence the selection of proposals for funding.

ISS construction continued with the integration of the starboard-zero truss structure and delivery of important hardware components for conducting research on board. Perhaps most important was the successful integration of the Microgravity Science Glovebox (MSG) in the Destiny Laboratory Module (the U.S. science hub). The MSG is a versatile platform offering hands-on research capability for a variety of experiments, from materials science and fluids to biotechnology and combustion.

The first materials science experiment in the unit, investigating the role of fluid motion on the growth of semiconductor single crystals, has already been completed, and a second investigation, on the formation of bubbles (defects) and their movement in a simulated metallic matrix, is being readied for operation at this writing. The addition of a fifth payload rack (Expedite the Processing of Experiments to the Space Station, or EXPRESS) and a freezer unit for storing biological samples in a thermally controlled environment will further the research capability on board the space station. The testing and integration of the Active Rack Isolation System on an experiment payload rack is another noteworthy milestone for science activities on ISS. The system is designed to provide close to pristine microgravity conditions to science payloads by damping onboard vibrations and disturbances.

In parallel with the hectic construction and hardware integration activities, a limited number of science and commercial experiments were conducted on the ISS, including the study of the effects of the space environment on materials, studies related to the human physiological system and the growth of plants and microbes in reduced gravity, the behavior of colloids, and tissue culture and protein crystallization experiments. These experiments were drawn from various NASA centers, the Commercial Space Program, and academic and research institutions. Student outreach activities featured Earth imaging opportunities and hands-on experiment preparation for protein crystallization studies performed in orbit.

As OBPR continues to fine-tune the science objectives in its purview with focused thrusts into high-priority research areas, the strength of the current program continues to lie in ground-based research comprised of more than 400 principal investigators doing peer-reviewed fundamental research in the traditional areas of biology, materials science, fundamental physics, fluids, and combustion science.

As an example of newly found underlying principles, NASA-funded researchers at Harvard, through a series of extended duration (~2,400 hr) experiments on the ISS, observed unexpected demixing behavior in a colloid mixture. The experiment focused on the behavior of three different classes of colloid mixtures over time. Under one set of runs, the demixing of a colloid-polymer sample was studied over four decades of length scale, from 1 μm to 1 cm, as the sample phase-separated into two, a behavior that cannot be observed on Earth because sedimentation would cause the colloids to fall to the bottom of the cell faster than the demixing process could occur.

While the research community awaits NASA decisions on the direction of future research, the budgetary problems will severely limit the amount of microgravity science that will be performed on the station in the near future unless new sources of funding can be identified. ⩓

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