ACEs are high with space station colloidal research

August 25 2014

European Space Agency astronaut Paolo Nespoli operating the Light Microscopy Module microscope aboard the International Space Station on a previous mission. Credit: NASA

One global marketer took to space to find a way to be leaner and greener back on Earth. For Procter & Gamble (P&G), product innovation and improvement relied on use of the International Space Station (ISS) as a science platform for the Advanced Colloids Experiment-Microscopy-1 (ACE-M-1) investigation.

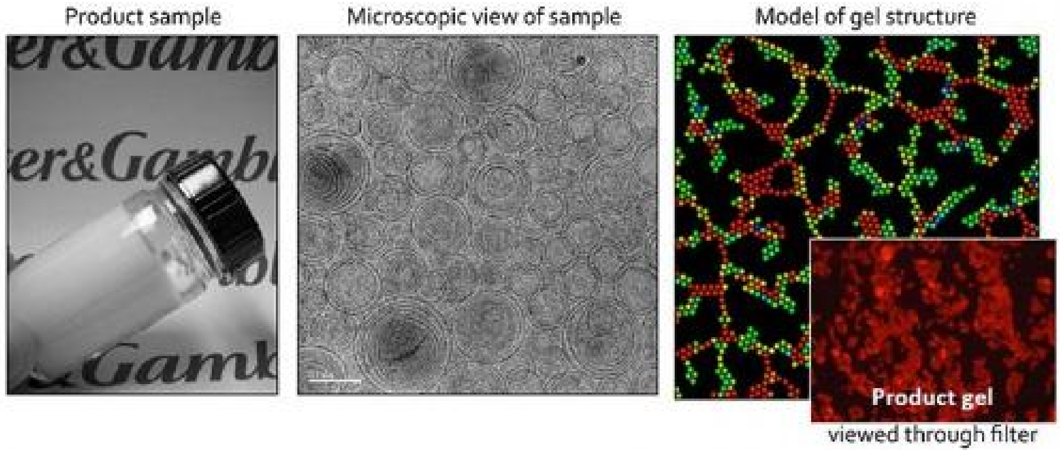
As a result, the researcher responsible for ACE-M-1 was a recipient of one of the "Most Compelling Results from the International Space Station in 2013" award. The honor, presented at the third annual ISS Research and Development conference on June 17, 2014, was "in recognition of taking consumer product design to entirely new heights."

The ACE-M-1 investigation was conducted on the space station from October 2013 to March 2014. The collaborative effort involved P&G, NASA's Glenn Research Center in Cleveland, Case Western Reserve University and the Center for the Advancement of Science in Space (CASIS).

ACE-M-1, the first in a series of such investigations aboard the space station, was designed to help researchers understand how to use small colloidal particles as stabilizers in products. The goal: to improve shelf-life stability by preventing large, active particles from creaming or settling to the bottom, a process known as sedimenting.

Colloids form when particles disperse throughout another substance. Colloidal gels make up many consumer products such as liquid detergent, shampoos, cleaners and medicine. In these systems, heavier particles settle to the bottom while lighter ones float to the top. This makes it hard to observe the underlying physics, which sedimentation often masks on Earth.

"When these products sit on a shelf for a significant length of time, they start coarsening and separating," said Bill Meyer, Ph.D., ACE-M-1 project scientist at Glenn. Coarsening occurs when smaller particles suspended in a liquid join to become larger particles, thereby altering its texture.



The gel structure, like that under investigation in the Advanced Colloids Experiment, is often dominated by fragile strands composed of many particles in a cross-section. Credit: NASA

"You see a top half and a bottom half that are different. Stabilizers keep the product doing what you want it to do. While we have a general understanding about what is happening at the particle level with these stabilizers, there's a lot more that we need to know," Meyer said.

By conducting research on the space station, scientists can use microgravity to create models and develop more universal theories by significantly slowing down the separation process. By better understanding these changes, producers can improve the products we use every day.

"I would say that the products that we're thinking about applying the science to, they are used daily by 4.8 billion people throughout the world," said Matthew Lynch, Ph.D., ACE-M-1, principal investigator and principal scientist at P&G in Cincinnati. "That's a significant number of people whose lives can be improved through innovations like this."

According to Ron Sicker, ACE-M-1 project manager, NASA and industry often have similar goals.

"For me as a NASA project manager, ACE-M-1 made me realize that many ground-based industries are in the same business as NASA, namely overcoming gravity," said Sicker. "We do this to enable space travel and exploration. Ground-based industries have to overcome gravity to produce better products."

The NASA Space Life and Physical Sciences (SLPS) program developed the Light Microscopy Module that has been operating on the space station since 2009, and has supported projects in gravity-dependent colloidal system physics since the mid-1990s. NASA collaboration in colloids research with scientists at P&G began in 2009 in response to the Microgravity Research Competition sponsored by the Heinlein Prize Trust. This collaboration led to the BCAT and ACE investigations—supported by the Space Life and Physical Sciences program—and later transferred to CASIS for the ACE-M-1 implementation.

The same technologies that help NASA pursue its goals of exploring our universe are helping improve our lives here on Earth. Space-based research can lead to better quality, reduced costs and greener, more concentrated products that use less plastic in their packaging. It could result in formulas that resist collapse to remain consistent and useful throughout their lifetimes.

"The ACE project is a multi-year, multi-experiment effort through at least 2020 on the space station, with approximately 15 experiments," said Sicker. "ACE-M-1 is the first. ACE-M-2 is currently being operated on the space station and continues work in phase separation and how to influence phase separation."

ACE-M-3 with New York University is the next planned investigation. It will study colloidal self-assembly. As the ACE experiments progress they will expand from applied research to more theoretically based research and add features to control and influence samples with temperature and electric fields.

"In the end, all the work links together with modeling and theoretical analysis," said Sicker. "The space station provides the platform to observe these very complex processes on a timescale that is thousands of times longer than on Earth. Colloids, including chemical products derived from petroleum, account for approximately 30 percent of the manufacturing and industrial Gross Domestic Product of the U.S. So the work is very important to the U.S. economy."

Provided by NASA

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