Flexing new muscles on the International Space Station

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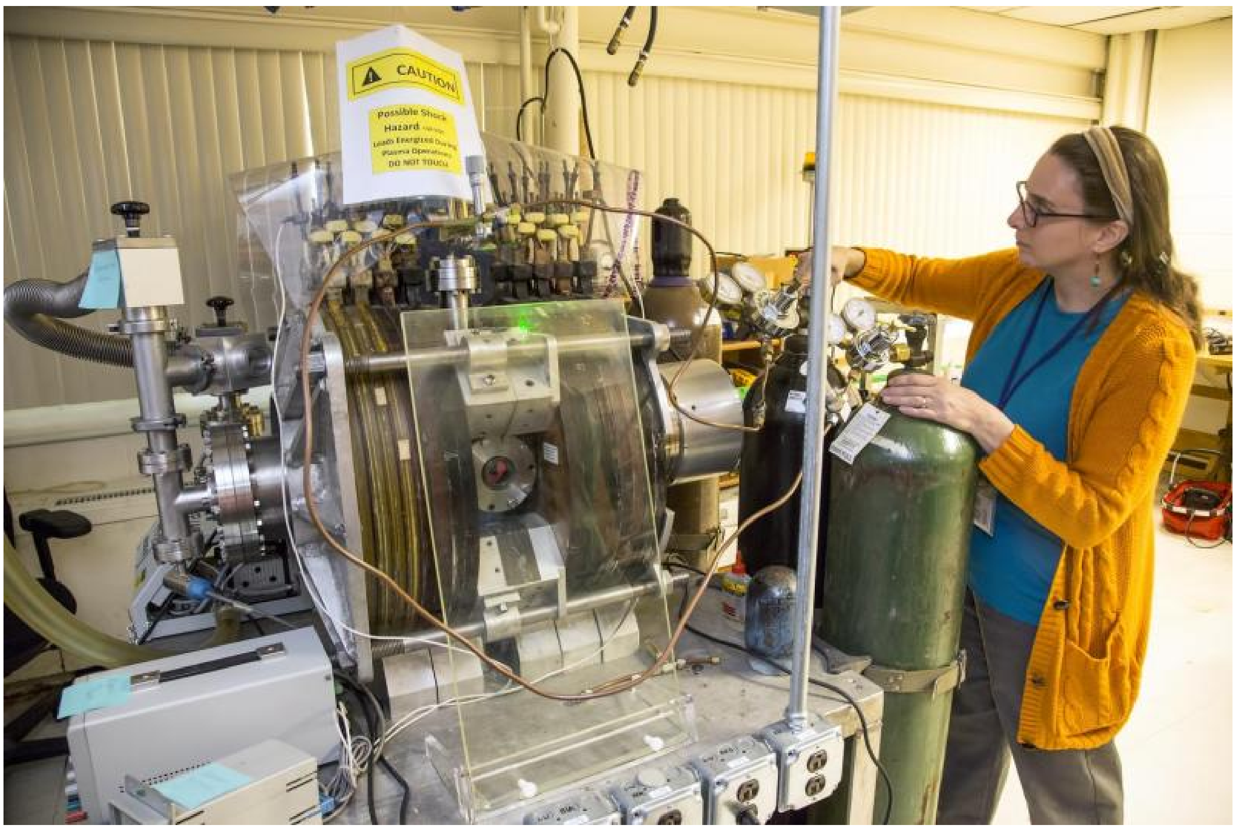

Lenore Rasmussen, Ph.D., principal investigator of the Synthetic Muscle investigation, checks the pressure during the oxygen plasma treatment of titanium metal support mounts at the US Department of Energy's Princeton Plasma Physics Laboratory. Credit: Elle Starkman, PPPL

When people conjure an image of a robot in their mind, they may imagine something out of a steampunk story—complex gears, rotors and clockworks. All metal, no muscle—but that's all about to change.

An American company creates muscles out of an advanced smart material that could be used in robots, expanding its capabilities while enabling them to go places considered too dangerous for humans. As astronauts on the International Space Station (ISS) study how the material reacts to the space environment, scientists on Earth are investigating the application of these same muscles in prosthetics, allowing fabrication of extremely realistic replacements for people who have lost limbs.

"For space robots and people on Earth, I want to develop a realistic prosthetic arm in form and function," said Lenore Rasmussen, Ph.D., founder of Ras Labs in Quincy, Massachusetts, and the principal investigator and inventor of Synthetic Muscle. "I envisioned designing something as delicate as a human hand with customized motion and control for an individual's needs, restoring mobility and freedom to those who have been injured."

Synthetic Muscle is a material made from an electroactive polymer that contracts with an electric current and expands back to its original state when the charge is reversed. The sixth SpaceX cargo resupply mission that is planned to launch on April 13 will deliver the samples of the material to the space station. Astronauts there will expose the material to cosmic and solar radiation to evaluate its durability in the harsh environment. Last summer, the material performed well when exposed to high levels of gamma radiation at the U.S. Department of Energy's Princeton Plasma Physics Laboratory in New Jersey.

The third generation of the RasLabs Synthetic Muscle enhanced with carbon fibers, shown to be just more than 2 centimeters in length. Credit: Ras Labs

"Early indications from the ground-based experiments indicate the materials electroactive polymers are radiation resistant," said Rasmussen. "The next logical step is to test the material outside of our atmosphere where there is a full spectrum of solar and cosmic radiation to see if it would still function and could be used in robots in deep space where they may encounter even higher radiation levels and cosmic effects like high linear energy transfer (LET) particles."

Different variations of the material—with different additives and coatings—will be attached to the interior of the space station and photographed over the 90 day exposure before returning to Earth for material integrity and electroactivity tests.

According to Ras Labs studies, Synthetic Muscle can withstand extreme temperatures—from the cold of space at minus 450 degrees Fahrenheit to well above the boiling point of water at 275 degrees Fahrenheit.

Robots with these manufactured muscles could be used in areas unsafe for humans, such as potential nuclear disasters. Robots outfitted with hands built using Synthetic Muscle could go into dangerous areas and perform human tasks requiring fine motor skills, like turning knobs or pushing buttons, to mitigate a disaster.

The Earth benefits of synthetic muscle appealed to the Center for the Advancement of Science in Space (CASIS) in Melbourne, Florida, which manages commercial investigations on the ISS National Laboratory.

"At CASIS, we support projects with direct applications on Earth," said Warren Bates, CASIS director of portfolio management. "Synthetic Muscle lined up perfectly with our mission to drive studies in space to improve our quality of life, from medical applications to commercial products. The space station's extreme environment provides an ideal platform for testing and analysis of these materials."

The materials in Synthetic Muscle can be created with traditional plastics manufacturing processes or with another technology being tested on station: 3-D printing, or additive manufacturing. The polymer material can be designed for more flexibility and degrees of motion, or it can be formulated to provide more strength and durability.

"The synthetic muscle we have created directly converts electrical energy to motion without the need for belts, pulleys, gears or motors," Rasmussen said. "As a result, our materials will generate a new way of thinking about motion, simplifying product design and increasing reliability by minimizing the number of parts that can break down in a device. This is revolutionary science."

Provided by NASA

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