Researchers develop new solar sailing technology for NASA

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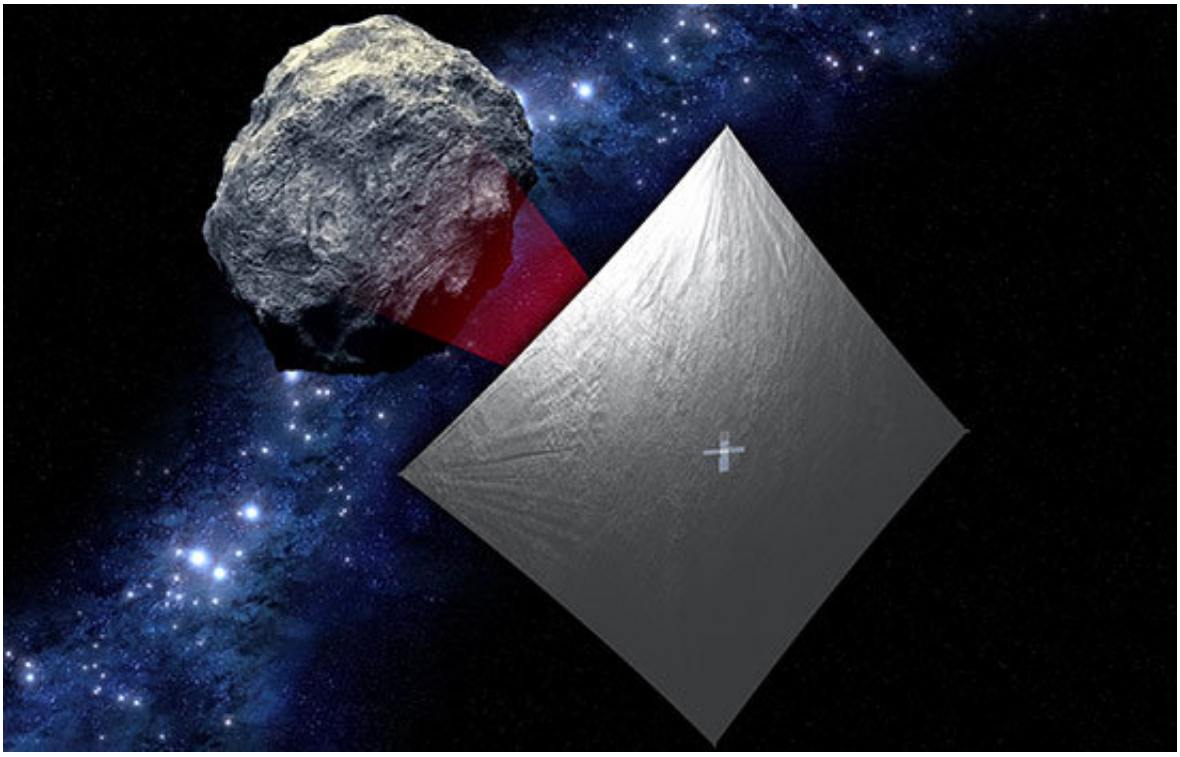

This concept image shows reflective-light solar sails attached to NASA's Near-Earth Asteroid Scout as the satellite conducts an experiment. An RIT scientist is advancing the next-generation of solar sails using new photonic materials. Credit: NASA

Spacecraft outfitted with sails and propelled by the sun are no longer the stuff of science fiction or theoretical space missions. Now, a Rochester Institute of Technology researcher is taking solar sailing to the next level

with advanced photonic materials.

Metamaterials—a new class of manmade structures with unconventional properties—could represent the next technological leap forward for solar sails, according to Grover Swartzlander, professor in RIT's Chester F. Carlson Center for Imaging Science. He proposes replacing reflective metallic sails with diffractive metafilm sails. The new materials could be used to steer reflected or transmitted photons for near-Earth, interplanetary and interstellar space travel.

"Diffractive films may also be designed to replace heavy and failure-prone mechanical systems with lighter electro-optic controls having no moving parts," he said.

Swartzlander is leading an exploratory study supported by phase one funding from NASA's Innovative Advanced Concepts program. The nine-month, $125,000 award encourages development of visionary technology with potential to revolutionize future space exploration. The Optical Society is hosting an incubator meeting, Metamaterial Films for In-Space Propulsion by Radiation Pressure, Oct. 7-9 in Washington, D.C., to create a roadmap for advancing metamaterial sails on low Earth-orbiting satellites called CubeSats. Swartzlander will facilitate the meeting with co-organizers Les Johnson, manager of the In-Space Propulsion Technology Projects Office at NASA Marshall Space Flight and principal investigator of NASA Near-Earth Asteroid Scout mission, or NEA Scout; and Nelson Tabirian, president of BEAM Co., which specializes in optical technologies and materials.

"CubeSats are becoming of great national importance for science, security and commercial purposes," Swartzlander said. "The potential to raise, de-orbit or station-keep hundreds of CubeSats from low Earth orbit would be a recognized game changer that would build enthusiasm and advocacy among the growing small-satellite community of students,

entrepreneurs and aerospace scientists and engineers."

The solar sails attached to NASA’s Near-Earth Asteroid Scout were tested in June in a clean-room at NeXolve Corp. in Huntsville, Ala. RIT professor Grover Swartzlander and mechanical engineering undergraduate Amber Dubill, a student leader in RIT’s Space Exploration research group, attended the test deployment. Credit: NASA/Emmett Given

NEA Scout will be the first CubeSat science mission having attached sails. It is one of 13 satellites that will conduct science and technology investigations as part of NASA's Exploration Mission-1. EM-1 is slated to launch this year on the new Space Launch System rocket. When deployed, NEA Scout's aluminum coated polyimide sail will reflect sunlight to propel the reconnaissance robotic spacecraft on its two-year cruise.

Swartzlander said diffractive metafilm sails could correct known limitations of reflective metallic sails—overheating, inefficient use of photons and excessive tilt of the spacecraft—because the new materials can:

- Lower absorption: The proposed diffractive surfaces would eliminate problems inherent in the metallic-coatings, which heat and compromise sail substrates;
- Reuse of photons: Diffractive sails would recycle transmitted photons, converting them to solar-electric power or diffracting the light twice for added momentum. (Reflective sails reflect photons back into space or absorb in the metallic coating); and
- Improved orientation: Diffractive sails maintains a more efficient position facing the sun, allowing highly efficient propulsion and generation of solar electric power on embedded photovoltaic cells. (Reflective sails work best when the spacecraft is tilted. However, this orientation decreases the projection of solar power upon the sail.)

"Diffractive sails may also be designed for laser-based propulsion, a decades-old concept that has recently attracted significant interest from private investors, resulting in a program called Breakthrough Starshot," Swartzlander said.

A leader in his field, Swartzlander has conducted pioneering research on the optical vortex coronagraph, optical vortices, solitons, coherence theory, optical tweezers and optical lift. He is editor-in-chief of the *Journal of the Optical Society of America B*.

Provided by Rochester Institute of Technology