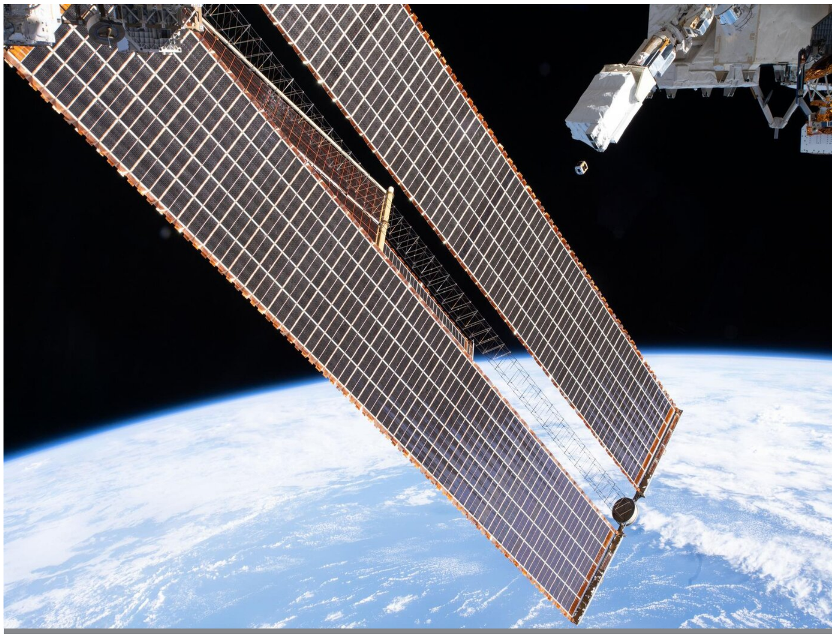


National Aeronautics and
Space Administration

TECHNOLOGY SOLUTION

Materials and Coatings

Origami-based Deployable Fiber Reinforced Composites

Using the shape memory effect to deploy structural composite materials

Inventors at the NASA Langley Research Center have developed a new UV (ultraviolet)-curable polymer carbon fiber composite and the origami-based deployable structures that are made from the new composite. The new composite and associated origami deployment system were developed for use in stronger, more reliable deployable space structures. These structures include beams for deployable habitats, booms, solar array frames, and antenna supports among others. The polymer shape memory effect allows the origami composite structures to be stored in a small, lightweight package and deployed on-site (i.e., in orbit, on the moon, etc.) through heating. The origami-based composite assemblies outperform other composite-based deployable structures in strength, are lighter than metals, are not susceptible to gas leaks like inflatable structures, and do not require motors to deploy.

BENEFITS

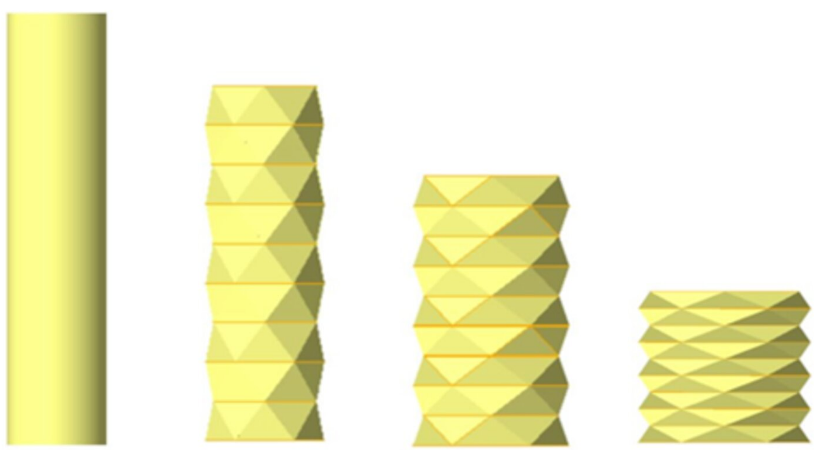
- Not prone to failure: telescoping, motor driven, and inflatable structures have failure potential from parts not working or gas leaks.
- High strength when deployed: demonstrated to have at least a 600 kg load capacity under Earth gravity.
- Simple, automatic deployment mechanism: the origami-inspired folding mechanism only requires heat to deploy, no manual intervention.
- Small stowage volume: the composites can be folded and packaged into a small volume for launch.
- Lightweight: carbon fiber polymer composites are lighter weight than typically used metals.

THE TECHNOLOGY

Deployable space structures often rely upon telescoping or folding structures that either must be manually deployed or deployed by attached motors. These structures are often made from heavier (relative to carbon fiber composites) metals to provide enough strength to support a load. As such, there is a need for in-space structures that are lightweight, can be packaged compactly, and can be deployed easily.

The composite material developed here does not require high temperature baking to cure the polymer, rather relying on UV light to solidify the polymer component. The composite is then included into origami-based structures that can fold and deploy using the polymer shape memory effect. The composite is first “trained” to assume the deployed structural shape when heated; it is then folded like origami and “frozen” into the packaged shape for storage and launch. Combining the composite material with the origami-inspired design leads to high strength structures (can hold at least 600 kg on Earth). To date, a ~5-inch prototype structural bar has been produced using the UV-curable composite and further development is on-going at NASA Langley.

The deployable origami composite structures are at technology readiness level (TRL) 4 (component and/or breadboard validation in laboratory environment) and are available for patent licensing.



Computer models of the composite origami structures.

APPLICATIONS

The technology has several potential applications:

- In-space uses: replacing metal support structures like boon antennae supports, solar sail supports, etc.
- Military: deployable habitats and mobile barracks.
- Consumer goods: tents, camping equipment, etc.

PUBLICATIONS

Patent Pending

Origami-based Composite Space Structures, Rebecca Hall, Jir and Jeff Hinkley, 2021 Fall Student Research Symposium, Dec https://ntrs.nasa.gov/api/citations/20210025400/downloads/R S-Presentation.pdf

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