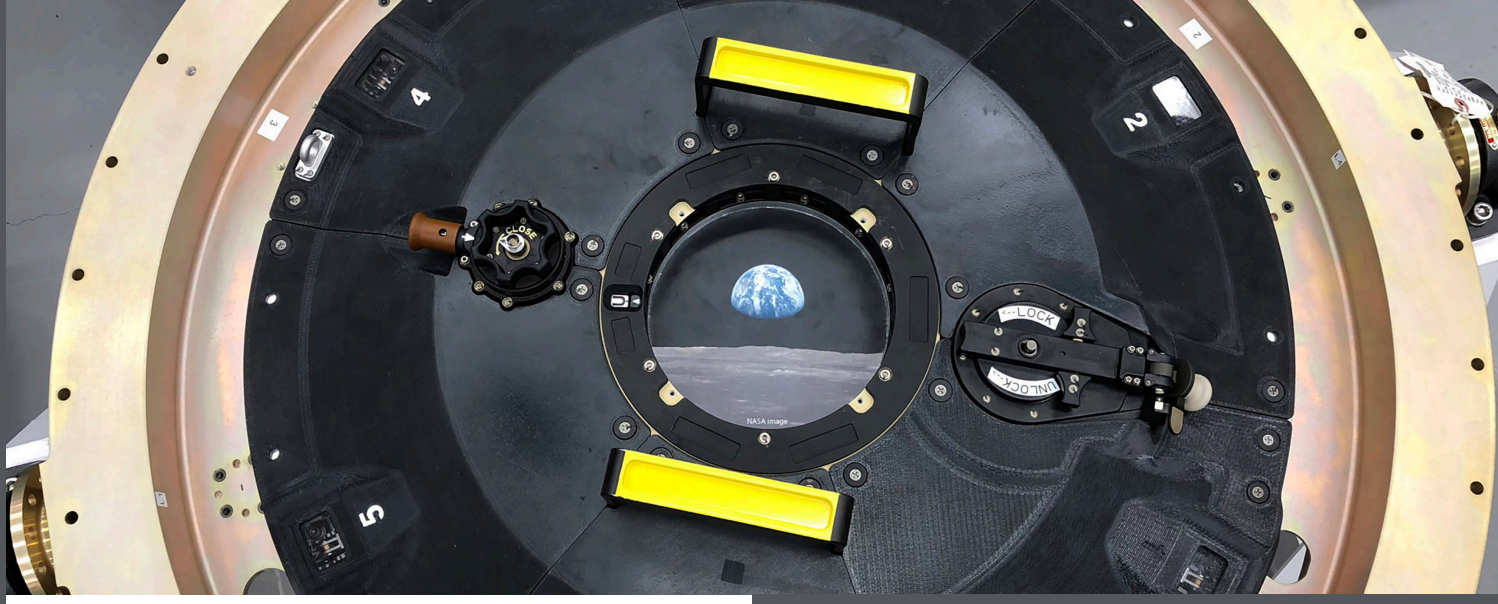

Deep Space with Humans on Board

Humans On Mars

If space is the final frontier, then human travel in to deep space, beyond the Moon, is the ultimate frontier. NASA's Orion program intends to do just that – travel with humans on board back to the Moon and out into deep space, and one day soon, Mars.

But before human travel, NASA is launching a series of test missions to target risk reduction, efficiencies identification, and industry partnerships enhancement. Exploration Flight Test-1 has already been successfully executed and now NASA is poised to launch the next un-crewed phase of its mission; Artemis 1. In 2024, Artemis 2 will follow, but with one major addition; this spacecraft will be crewed.

> "We've been able to see orders of magnitude savings both in cost and schedule on all of these parts because the part builds are very consistent, the material properties are well understood, and the build parameters are becoming better understood."

Brian Kaplun
Lockheed Martin Space

stratasys

Lockheed Martin

Deep Space with Humans on Board

The conditions of deep space require a multi-mission approach with rigorous parts testing and the construction of a new spacecraft for each mission. This ensures both the integrity of the parts but also poses a challenge for Lockheed Martin, prime contractor for the Orion vehicle: repeatability.

“The focus of the Artemis Orion production spacecraft is that you’ll start to limit the design changes and the design updates as you go from one mission to the next,” said Brian Kaplun, a Lockheed Martin Fellow and subject matter expert in additive manufacturing. The idea is that a part would be thoroughly tested before going forward “because these capsules become copies of one another, so that each one is an enhancement, but the baseline remains static.”

Material Makes the Part

In its quest to position the nation and U.S. companies as world leaders, NASA is using advanced manufacturing techniques, such as Additive Manufacturing (AM), on board both the rocket and spacecraft. In fact, , Artemis I has more than 100-3D parts on board. “What’s become apparent recently is the maturity of the 3D printing systems,” said Kaplun. “The actual machines doing the printing are more reliable and when you install a new piece of equipment and you print a part on two separate machines with the type of quality controls we have in place, you will get a part that will perform very similarly.”

Lockheed Martin Space has seven 3D printers in its Additive Manufacturing Lab, the latest of which is the Stratasys Fortus 900mc™, with its higher thermal capability and ability to print larger parts. With each capsule newly constructed for that flight, the importance of repeatability takes on a new significance. “It becomes a lot more attractive to be able to utilize additive manufacturing on EM-1 and have that high degree of confidence for the same part on Artemis II, III and beyond,” said Kaplun. “It’s a really attractive time to be able to break in with additive parts.”

In addition to the manufacturing process, the materials used have a rigorous needs assessment attached to them. “The granddaddy of flight components has been the ULTEM™ 9085 resin material,” said Kaplun. “It’s well-understood, has excellent strength properties, excellent thermal properties, excellent out-gassing; it really is ideal for utilization in space environments.” But one property has been missing in this material for use in deep space: electro-static dissipative (ESD) capabilities.

“There’s always been the attraction of having an ESD-compliant polymer,” said Kaplun. “There were ESD compliant polymers available but they were ABS, and ABS is not something we would be able to fly on a spacecraft,” due to mechanical, functional and dimensional stability issues.

Antero 840CN03 is a Stratasys PEKK-based high-performance polymer with low- outgassing properties and ESD capability. “We’ve been able to see orders of magnitude savings both in cost and schedule on all of these parts because the part builds are very consistent, the material properties are well understood, and the build parameters are becoming better understood. Also, the properties of the [Antero 840CN03] eliminate a large amount of the post processing that we would otherwise have had to do. So that also nets a tremendous amount of time savings.” Stratasys and Lockheed Martin Space partnered to launch the first phase of a robust dataset intended to aid in the qualification of Antero 840CN03 for flight parts. While the first phase only includes mechanical tensile data, further phases are planned to add additional mechanical tests. This data will enable the adoption of more AM parts on current and future programs.

Deep Space with Humans on Board

ESD PEKK “has enabled us to achieve very consistent builds that move beyond the realm of prototyping and into production in a manner that is consistent,” said Kaplun. “It yields repeatable results, and we can now, with a high degree of confidence, know that we’re not just making a single part but a family of parts.”

The Stratasys Antero (ESD) part on Orion is the outside of the docking hatch and measures one meter in diameter. “The hatch covering is made entirely of Antero 840CN03,” said Kaplun. ULTEM™ 9085 resin covers would still have needed some sort of coating or nickel plating to deflect the static charge, making Antero 840CN03 very attractive to Lockheed Martin.
The six-piece part joins together to form a ring on the outside of the docking hatch, “much like a pizza in six slices with a hole in the middle, or a donut,” said Kaplun.

Lockheed Martin expects more 840CN03 parts will continue to be added to Orion as the program evolves. Kaplun sees something very special about a space mission that’s going to have people on board. “There’s that intimate connection when you can associate yourself with the astronauts going on the mission, and it’s nice to be able to tie-in technological advancement [like 3D printing] to these missions.”

NASA’s Artemis 1 mission is slated to launch in the summer of 2022, with Orion, and its 3D printed parts, on board.

> “We are continually looking for ways to drive innovation for flightqualified materials and additive manufacturing is the key to that endeaver. Through our collaboration with Stratasys and MSU Denver, we have collected the data necessary to qualify Antero 840CN03 for flight parts and we are now able to expand our use of the material beyond our initial applications on the Orion vehicle.”
>
> Cris Robertson
> Lockheed Martin Space

The electro static dissipati ve qualities of Antero™ (ESD) PEKK material make this part flight-worthy.

USA - Headquarters
7665 Commerce Way
Eden Prairie, MN 55344, USA
+1 952 937 3000

ISRAEL - Headquarters
1 Holtzman St., Science Park
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000

EMEA
Airport Boulevard B 120
77836 Rheinmünster, Germany
+49 7229 7772 0

ASIA PACIFIC
7th Floor, C-BONS International Center
108 Wai Yip Street Kwun Tong Kowloon
Hong Kong, China
+ 852 3944 8888

stratasys.com
ISO 9001:2015 Certified

GET IN TOUCH.
www.stratasys.com/contact-us/locations