

Laser Beam Welding Advancements for In-Space Servicing, Assembly, and Manufacturing

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NASA is currently working to develop in-space servicing, assembly, and manufacturing (ISAM) capabilities for low Earth orbit and the lunar surface. One crucial technology for this effort is laser beam welding. Laser systems can perform joining, cleaning, cutting, and repair activities, which will enable the construction of large in-space structures that could not fit on a single launch vehicle, such as trusses for solar panels, radiators, or communications infrastructure. Multiple projects studying laser welding for space applications are currently underway at NASA Marshall Space Flight Center. One of these, the DIsk-Shaped Configurable and Modular vAcuum uNit (DISCMAN), is a compact vacuum chamber designed to support parameter development for laser welding in microgravity. It contains a rotating platen with weld samples made from aluminum, steel, and titanium, a high-power infrared laser, and integrated pumps for pulling vacuum inside the sample cartridge. The DISCMAN payload is planned to launch to the International Space Station, where welds will be performed under sustained microgravity inside the Bishop Airlock. Another effort underway at Marshall is the Lunar Assembly and Servicing by Autonomous Robotics (LASAR) initiative. This project uses a space-rated robotic arm equipped with a laser weld head, wire feeder, and multiple cameras to perform welds in a thermal vacuum chamber simulating the lunar surface environment. Some of these welds are done on snowflake joints, which are specially designed to slot together to join segments of truss structures, allowing for the construction of tall surface infrastructure. DISCMAN, LASAR, and other projects are being carried out to advance the technological maturity of in-space laser beam welding, collect data to inform computational models, and learn reliable processes for creating weld joints in space. This work supports NASA's greater goals to expand humanity's presence in low Earth orbit, establish a permanent moon base, and eventually send crewed missions to Mars and beyond.