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IN-SPACE MANUFACTURING OF TRUSSES FOR DEPLOYABLE SOLAR PANELS

Abstract

Nearly all spacecraft rely on photovoltaic solar arrays to generate power in orbit. Over time, power generation has increased due to improved solar cell efficiencies and an evolution from body-mounted solar panels to rigid and flexible deployables. However, the design of these solar panels is inherently constrained by the need to survive the launch to orbit, which includes intense vibration, acceleration, and packaging constraints. In-space manufacturing (ISM) presents a promising opportunity to improve the specific power (W/kg), stowed volume efficiency (kW/m^3), $andspecificcost$(/W) of spacecraft solar panels, thus enabling ambitious new missions. With ISM, solar panel support structures can be fabricated to simply meet on-orbit loads instead of launch loads, thus saving significant mass and cost relative to terrestrially manufactured and launched solar panels. This paper will first explore the material selection criteria used to ensure ISM trusses can survive in the space environment, which involves atomic oxygen exposure, UV degradation, and thermal cycling. Then, a discussion will be presented on the current state-of-the-art in manufacturing these materials in a microgravity and ultravacuum environment. Finally, the author will present the result of structural optimization for the support structure of a flexible solar array blanket subjected to selected manufacturing constraints, such as minimum wall thickness and constant cross section. Overall, this work will serve to inform ISM technology development efforts in terms of the types of materials to be processed, as well as the impact of manufacturing capability on the mass savings of the resulting structurally optimized truss. The level of ISM technology development achieved will directly impact the applicability of this technology for future high-power missions, such as human-class solar electric propulsion missions, communications relay satellites, and synthetic aperture radar sensors.