IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Interactive Presentations - IAF MATERIALS AND STRUCTURES SYMPOSIUM (IP)

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ULTRA-LIGHTWEIGHT 3D LATTICE STRUCTURES OF SPACECRAFTS: NOVEL DESIGN AND IN-ORBIT APPLICATIONS

Abstract

Three dimensional (3D) lattice structures have been widely desired in spacecrafts for the characters such as ultra-lightweight, excellent designability and multi-functional integration. In recent years, the rapid development of additive manufacturing (AM) technology, especially selective laser melting (SLM), promotes the high-precision fabrication of three dimensional lattice strut structures. However, most lattice units employed in the design of AM structure did not consider the AM constraints, resulting in the low accuracy and poor mechanical performance of the as-fabricated parts. In this work, a novel design method of lattice unit, inspired by multi-fold rotational symmetry in crystallography, considering the geometric constraint of AM is proposed. The elastic constitutive relations of the self-supporting lattice structured materials are obtained in theory and verified by experiments. Furthermore, the first satellite main structure made of self-supporting lattices was designed and launched with QIANGSHENG-1 satellite on August 17, 2019. The dimensions of the satellite structure are about 0.5 m in three dimensions. The structure mass-to-satellite mass ratio is 8