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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
New Materials and Structural Concepts (4)

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DESIGN STRATEGIES FOR SPACE SYSTEMS AND SUBSYSTEMS USING ADVANCED NANO-MATERIALS AND MANUFACTURING TECHNOLOGIES

Abstract

Space structures represent a class of optimized structural designs within lightweight structures. The major constraints in the optimization process are Mass and Stiffness requirements. In addition, case-by-case constraints may exist for sub-system structures. The ability to deliver optimized structures is always subject to the constraint of the manufacturing feasibility of the designs which is directly related to cost. Traditional materials for space include aluminum and carbon fibers, with the latter gaining use over time. The use of composite materials has been favored in large satellites but has not been embraced so extensively in smaller satellites (e.g. CubeSats). This forms the basis of our considerations within this work. In this work, we summarize the use of various advanced materials in space applications taking into consideration the benefit of their use in different levels of consideration. Focus is placed on composite materials, with which 40% weight saving in structure has been reported even for micro-satellites, and performance achievements are discussed. Recent developments in advanced materials focusing on enhancement through nanotechnology products are reviewed, summarizing the achievements following this trend in research. Furthermore, reported developments in advanced and emerging manufacturing methods (e.g. fiber steering, additive manufacturing), where substantial performance increase has been reported reaching e.g. 30% increase of the structural dynamic characteristic of a subsystem while maintaining the same mass, are also assessed in the view of developing more efficient design and manufacturing practices.