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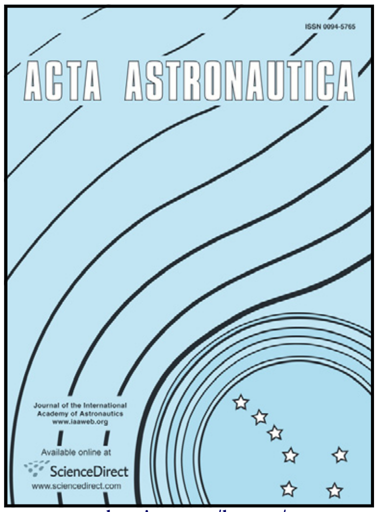

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PII: S0094-5765(15)00122-8
DOI: http://dx.doi.org/10.1016/j.actaastro.2015.03.022
Reference: AA5390

To appear in: *Acta Astronautica*

Received date: 12 December 2014
Accepted date: 19 March 2015

Cite this article as: Marina M. Toropova, Craig A. Steeves, Adaptive bimaterial lattices to mitigate thermal expansion mismatch stresses in satellite structures, *Acta Astronautica,* http://dx.doi.org/10.1016/j.actaastro.2015.03.022

Adaptive bimaterial lattices to mitigate thermal expansion mismatch stresses in satellite structures

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Abstract

Earth-orbiting satellites regularly pass from sunlight to shade and back; these transitions are typically accompanied by significant temperature changes. When parts of a satellite that are made of different materials are subjected to large temperature changes, thermal mismatch stresses arise that are a function of the temperature change and the difference in coefficients of thermal expansion (CTEs) between the two materials. These thermal stresses are linked to undesirable deformation and, through long-term cycling, fatigue and failure of the structure. This paper describes a type of anisotropic lattice that can serve as a stress-free adaptor between two materials, eliminating thermal mismatch stresses and their concomitant consequences. The lattices consist of planar nonidentical anisotropic bimaterial cells, each designed based on a virtual triangle. Physically the cells consist of a triangle made of material with higher CTE surrounded by a hexagon made of material with lower CTE. Different skew angles of the hexagon make a particular cell and the whole lattice anisotropic. The cells can be designed and combined in a lattice in such a way that one edge of the lattice has CTE that coincides with the CTE of the first part of the structure (substrate 1), while the other edge of the lattice has CTE equal to the CTE of the second part of the structure (substrate 2). If all joints between the parts of each cell, neighbouring cells, and the lattice and the substrates are pinned, the whole structure will be free of thermal stresses. This paper will discuss the fundamental principles governing such lattices, their refinement for special circumstances, and opportunities for improving the structural performance of the lattices. This

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