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Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

Author: Dr. Liu Dali
Aerospace System Engineering Shanghai, China, 4datianwang@163.com

Dr. Yan Biao
China, a805ases@163.com
Dr. Guangqiang Fang
Aerospace System Engineering Shanghai, China, house19@163.com
Mr. Chao Xie
Aerospace System Engineering Shanghai, China, xchnuaa@126.com
Dr. Shi Hang
China, shihang@163.com
Prof. Fujun Peng
Shanghai Key Laboratory of Spacecraft Mechanism, China, pfj_tj@yahoo.com
Ping Tang
Aerospace System Engineering Institute, China, sanhudu@163.com

A BIONIC STRUCTURE FOR FLEXIBLE SOLAR ARRAY VIA TOPOLOGY OPTIMIZATION

Abstract

The object of this study is to establish a new design methodology for ultra-light solar array paddles, which is defined as "bionic structure". This concept is designed aiming at power density of more than 100W/kg, while the power density of current rigid type solar array is from 30 to 40W/kg and the current flexible types have higher density from 50 to 60 W/kg. However, the flexible ones are difficult to be used on the small satellite, because it requires many additional heavy structures and mechanisms. It is well known that ultra-structures in nature, such as feather and leaves, have a gradient structure as their reinforcing rib. The new concept solar array presented in this paper consists of film solar cell, thin film substrate, bionic gradient frame structure and spring hinge. The gradient structure can be optimized by topological optimization and fabricated by additive manufacturing. First of all, the minimum structure mass has been set as the optimization objective, the frequencies of deployed and folded models have been set as constraints, and the form and size of gradient structure can been optimized then. Second, the FEA model including thin film, gradient structure, and hinge has been built in Abaqus, and it also includes film tension and the connect layer between film and gradient structure. At last, the simulation experiment, in which the performance indexes of bionic solar array have been compared with traditional rigid one, has been studied to validate the new concept.