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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures II - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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TOPOLOGY OPTIMIZATION AND FDM PROTOTYPING OF BIONIC INSPIRED STRENGTHENING-RIBS IN MEMBRANES OF SPACECRAFT

Abstract

Deployable membrane structure widely used in large spacecraft such as solar cell array, solar sail, which has the advantages of large area, light weight, small folded size, and can effectively reduce the cost of research and launch of the spacecraft. Getting inspiration by the ultralight structure ribs of leaves and wings in nature with excellent structural rigidity and strength, gradient structure strengthening ribs has been added on membranes to enhance their ability of resist tearing. The problem that spacecraft membranes is easier to be tore open has been mainly focused in this paper, and biomimetic strengthening ribs structure has been proposed for a space membrane structure which used interdisciplinary strengths, such as bionic technology, topological optimization technology, composite materials technology, and rapid prototyping. The optimization method and process method of biomimetic strengthening ribs has been studied. Through topology optimization, biomimetic ribs with good tensile and tear capacity has been obtained via ABAQUS. The topology optimization structure has been remodeled via three-dimensional model. Carbon fiber reinforced PEEK composites which having priority of thermal stability and good processing properties in strengthening ribs of membranes structure has been selected. FDM technology has been utilized to print the strengthening ribs of membranes. Deformation and tearing of two kinds of membranes with and without strengthening ribs has been compared by tear-resistance tests. Experimental results showed that membrane with biomimetic strengthening ribs structure has better mechanical properties, and has important significance to avoid membrane tear and ensure the spacecraft orbital lifetime.