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

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EXPERIMENTAL VALIDATION OF DEPLOYABLE TAPE SPRING HINGE EMBEDDED WITH SURPERPLASTIC SHAPE MEMORY ALLOY

Abstract

Satellites generally have deployable appendages due to the limited space available on the Space Launch Vehicle (SLV), which essentially includes a deployment mechanism for stowing during launch and the release into orbit. The deployment phase is vital to the mission's success, accordingly, the deployment mechanism must guarantee high deployment reliability. Tape spring hinge (TSH) is typically used as a deployable mechanism to release the deployable structures owing to the design simplicity, lightweight, low cost, and high deployment reliability. However, if the TSH is designed to have high deployed stiffness, the kinetic energy during deployment becomes excessive, resulting in high deployment shock that could damage the deployable structure or the hinge itself. In this study, we propose a novel TSH with the superelastic Shape Memory Alloy (SMA) to enhance the performance of the conventional TSH in terms of the attenuation of latch shock. The superelasticity of SMA is a distinct characteristic of SMA material produced by stress-induced phase transformation from the austenite to the martensite phase which can be deformed significantly without plastic deformation and restored its original configuration upon unloading. This characteristic is also associated with effective hysteretic damping capability owing to the phase transformation. In addition, to maximize a damping capability on the proposed TSH, multilayered thin plates were attached by double-sided acrylic tapes. The feasibility and design effectiveness of the proposed hinge was validated through a free vibration test and deployment test.