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PASSIVE VIBRATION SUPPRESSION OF SOLAR ARRAY BY USING HYPERELASTIC SHAPE MEMORY ALLOY

Abstract

A suppression of vibration induced by dynamic motion of a large deployable solar array is one of the important technical tasks to actualize advanced space missions requiring a strict pointing requirements such as inter-satellite linking with laser communication, super resolution earth observation, etcs. Pssive vibration suppression of solar array is attractive method for space applications due to its advantages of system simplicity, reliability and system stability without spill-over problem mainly experienced in active system. In this study, a novel passive vibration damping device for large deployable solar array was proposed and investigated focusing on the hyperelastic characteristics of shape mempry alloy (SMA). A strategy to achieve a passive high damping is to apply hyperelastic SMA on a yoke structure located near the solar array root hinge. The hyperelasticity is a unique characteristic of SMA material occurred by stress-induced phase transformation from the austenite to the martensite phase and this can be deformed considerably without being plastically deformed and recover its original shape upon unloading. In addition, SMA exhibits effective hysteretic damping when the stress applied on the SMA exceeds the critical stress point at which the phase transformation appears. Therefore, this might be a suitable smart material used for yoke structure where a relatively larger defomation is induced. To increase a higher damping on the SMA yoke structure even under a relatively small deformation, we proposed to apply multilayered thin plates with viscos lamina adhesive layers of acrylic tapes on the SMA yoke structure. The effectiveness of a high damping performance of the proposed system was demonstrated by free vibration tests and sine sweep tests of a solar array simulating dummy with a 0.75m-long flexible structure with the 1st eigenfrequency of 1Hz. The test results indicated that the vibration is quickly damped out as increasing the multilayered viscos lamina adhesive layers. The free vibration tests when the yoke structure is exposed to the various temperature ranges are also perfomed to measure the damping characteristics. In addition, the performance variation induced by a delamination on the viscos lamina adhesive layers after thermal cycling loading was also validated under a predictable on-orbit temperature condition.