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Author: Dr. Jae Hyuk Lim
Korea Aerospace Research Institute (KARI), Korea, Republic of, ljh77@kari.re.kr

Dr. Do-Soon Hwang
Korea Aerospace Research Institute (KARI), Korea, Republic of, dshwang@kari.re.kr
Mr. Kyung-Won Kim
Korea Aerospace Research Institute (KARI), Korea, Republic of, kwkim74@kari.re.kr
Mr. Sun-Won Kim
Korea Aerospace Research Institute (KARI), Korea, Republic of, sunwkim@kari.re.kr
Mr. Youngik Yoo
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, yooyik@kaist.ac.kr
Prof. Jung Ju Lee
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, leejungju@kaist.ac.kr

DESIGN AND ANALYSIS OF A NOVEL LOW-SHOCK RELEASE DEVICE USING TWO-WAY SHAPE MEMORY MECHANISM OF SMA FOR SPACECRAFT APPLICATION

Abstract

In this paper, a novel low-shock release device for spacecraft with the aid of the two-way shape memory mechanism of SMA(Shape Memory Alloys) is introduced. Since AFRL(Air Force Research Laboratory)'s first attempt in 1993, low shock release devices are widely used in space industry in deploying instrument like solar array, balloon or in separation of small satellite from launch vehicle. Most important function is to release the instrument safely with low-shock (below 500g in any frequency) so that the instrument and spacecraft are not damaged during separation process. In addition to this, several features: short separation time(around 100ms), high preload(over 10,000kgf), reusability are also required. To develop such actuator, SMA(Shape Memory Alloys) having shape-memory effect(one-way memory effect and two-way memory effect) is widely used as the trigger or the load-bearing mechanism. In the case of SMA wire, usually, it works as the trigger with well-known one-way memory effect in commercial SMA actuator. Before re-using it, additional pre-straining process should be performed to make deformation up to a certain level. Moreover, replacement-kit including spools, plungers are replaced. In the low shock release device with two-way memory effect, the trigger mechanism is extremely simple because SMA remembers two different shapes: one at the low temperature and the other at the high temperature shape. It does not need any pre-straining process kit replacement as well as preserve major key requirement: low-shock, short separation time, high preload and reusability. To verify the proposed device, EM(Engineering Model) is constructed by combining with separation nut mechanism. Separation shock, time and preload are also investigated by several performance tests.