

ESA Contract No. 4000133267/21/NL/GLC/ov

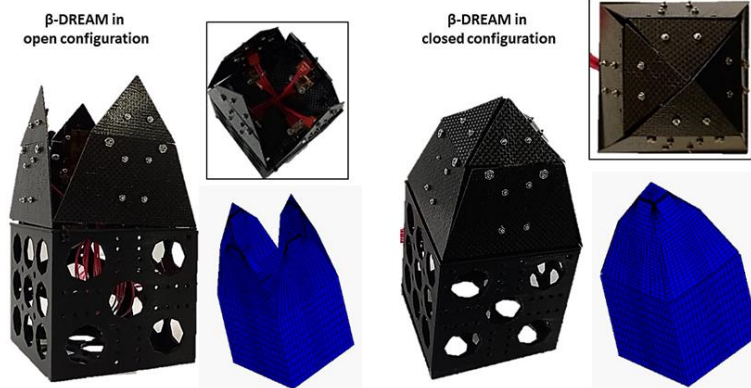
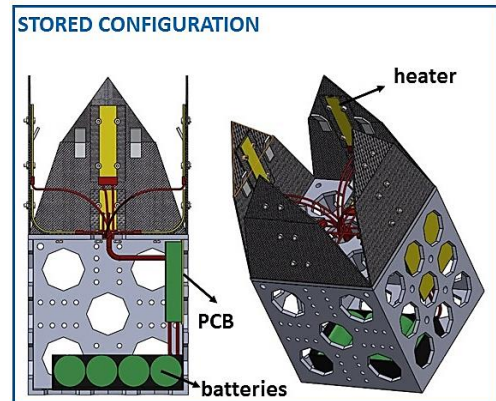
European Space Debris Suppression



S.Un.R.i.S.E.
Second University of Rome in Space Experiments

Executive Summary

A first prototype of a shape memory polymer composite (SMPC) grabbing device (called β -DREAM, *Debris Removal by the European Autonomous Module*) for space debris removal has been manufactured, and tested under several memory-recovery cycles, without evident damages. The prototype of the grabbing device is fully in composite, without mechanical parts apart from screws and bolts. The innovative β -DREAM device is about 130 g in weight, and is operated at 26 V, by a current of 2.45A, for a maximum power of 60 W. The recovery time is 3 min. The device has a square based pyramid structure to maximize the capture volume. Its size has been chosen to enter the volume of a 1U in the open configuration, and to be mounted on the top of a 1U. The modular approach was chosen to simplify and to optimize the assembly; 4 sub-components, indicated as "arms" or "fingers" represent the modules of the structure. Each arm is composed of passive parts, carbon fiber reinforced (CFR) laminates, and active parts, the SMPC hinges.



Passive parts are responsible for the debris confinement after capture, whereas the active parts switch from the open to the closed configuration by heating. The single arm is made with trapezoid and triangle CFR laminates (passive elements), and 2 SMPC hinges as active elements. In detail, one hinge, which refers to the "first level", connects the trapezoid CFR laminate to the top surface of the 1U. The second hinge,

which refers to the "second level", connects the triangle laminate to the trapezoid one. Bolts are used for assembling. The architecture of the SMPC hinge, which is 4-ply with 3 SMP interlayers, has been also selected on the basis of results from durability tests. In this project, 10 memory-recovery cycles have been repeated on laminates with different number of plies (from 2 to 8) in the cantilever configuration. Results show that damages do not occur at low number of cycles if the laminate is deformed in the elastic range at the test temperature. The functionality of the β -DREAM device was tested by capturing debris with different shapes and weights. During testing, debris had the relative linear speed of 10 mm/s, the rotational speed of 10 rpm, and were located with an angle of 5 deg, and a distance of 25 mm from the device axis. In all the tests, the grabbing unit was able to damp the debris rotation before the closure, without losing the contact.

