20th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Mitigation - Tools, Techniques and Challenges - SEM (4)

Author: Ms. Zaria Serfontein
Cranfield University, United Kingdom, z.serfontein@cranfield.ac.uk

Dr. Jennifer Kingston
Cranfield University, United Kingdom, j.kingston@cranfield.ac.uk
Dr. Stephen Hobbs
Cranfield University, United Kingdom, s.e.hobbs@cranfield.ac.uk

DEVELOPMENT AND VALIDATION OF DRAG SAILS FOR SPACE DEBRIS MITIGATION

Abstract

Space debris an increasingly serious threat to the future and on-going missions, partially due to the rapid growth of the small satellite market. The number of objects in low-Earth orbit and their combined mass have been steadily rising since the beginning of the space age, leading to involuntary collisions between operational payloads and space debris. As this number increases, the probability that these objects will impact an active spacecraft, potentially leading to the loss of the spacecraft, or dead satellites and rocket bodies, creating further debris, also increases. Now is the time to act and ensure future satellites aren't destined to become space debris.

In response to the growing number of small satellites with de-orbit periods far exceeding the lifetime of the satellites, Cranfield University has developed a family of drag augmentation systems. These lightweight, cost-effective sails are deployed at the end of a mission, increasing the drag area of a satellite and minimising the de-orbit period, thus reducing the probability of significant collisions. These are reliable solutions for de-orbiting small satellites, assisting in the conservation of the space environment, and could have further applications in mission extensions and active debris removal missions. Three drag sails designed, manufactured and tested at Cranfield University are currently in orbit, with two sails already successfully deployed.

This paper will highlight the work done to prepare these passive de-orbit devices for commercialisation. ESA's Clean Space initiative CleanSat previously highlighted several requirements which would need verification to qualify the drag sails and increase customer confidence. Of those requirements, the authors selected several to address, primarily focused on ensuring the drag sails will exhibit the expected performance during worst-case de-orbit scenarios. The results from a material testing campaign, quantifying the effects of atomic oxygen erosion on the aluminised Kapton sails, and an ESA Fly Your Thesis! parabolic flight campaign, assessing the scalability and modularity of the sails, will be summarised in this paper. Finally, the paper will conclude with an analysis of the accuracy and reliability of end-of-life de-orbit models, validated with results from the parabolic flight campaign and in-flight data from two deployed sails.

The low-Earth orbit environment is an incredibly value resource in itself. By polluting the environment, humanity runs the risk of restricting our access to space. Drag sails are one of many solutions which could aid in reducing the quantity of future debris without negatively impacting the momentum in the sector.