Proceedings of the Canadian Society for Mechanical Engineering International Congress
32nd Annual Conference of the Computational Fluid Dynamics Society of Canada
Canadian Society of Rheology Symposium
CSME-CFDSC-CSR 2025
May 25–28, 2025, Montréal, Québec, Canada

DEPLOYABLE COMPOSITE PANEL FOR THE ELECTROMAGNETIC DEORBITATION OF SATELLITES

Dorian Stefan Dumitru[1,3*], Ilyass Tabiai[2,3], David Melancon[1,3]
[1]Laboratory for Multiscale Mechanics (LM^2), Department of Mechanical Engineering, Polytechnique Montréal, Montréal, Canada
[2]Polymer and Composite Engineering Laboratory (LIPEC), Department of Mechanical Engineering, École de Technologie Supérieure (ÉTS), Montréal, Canada
[3]Research Center for High Performance Polymer and Composite Systems (CREPEC), McGill University, Montréal, Canada
*dorian-stefan.dumitru@polymtl.ca

Abstract

By 2030, the number of satellites orbiting the Earth is expected to exceed 1.7 million, contributing to an increase in space junk comprised of decommissioned satellites and collision fragments. To address this issue, the United Nations' *Space 2030* agenda calls for satellite providers to implement debris mitigation plans. Conventional deorbiting technologies, such as propulsion and robotic systems, are complex and add significant weight to the structure. Electromagnetic (EM) tethers, deployed at the satellite's end-of-life, offer a lighter alternative by generating drag forces when interacting with the Earth's EM field. However, these tethers remain non-functional deadweight during the satellite's mission. Here, we propose integrating EM tethers directly into the satellite's structure as fiber reinforcements within composite panels. At launch, the panels provide structural integrity to withstand vibrations. Once in orbit, controlled thermal degradation of the matrix triggers the passive deployment of the fibers into preprogrammed shapes, generating EM drag. Using a kinetic model, we first characterize deorbiting performance as a function of tether geometry, comparing simple (linear, circular) and more complex (zigzag, spider-web-inspired) configurations. We then present a proof-of-concept prototype to demonstrate the tether can self-deploy from a composite panel. The prototype is fabricated using 3D printing by integrating a nylon wire into a polyvinyl alcohol (PVA) panel. Upon immersion in water for 24 hours, the PVA dissolves, deploying the tether. We show that knotting the nylon in specific locations enables control over the final deployed shape. Our results highlight the potential of multifunctional composite panels that integrate EM deorbiting technologies directly into satellite structures.