Exploring Thermoplastics as a Sustainable Alternative for Satellite Structures

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Abstract

This study investigates the use of **reusable thermoplastic materials** as a sustainable alternative to aluminum in satellite bus structures, aligning with circular economy principles. By integrating thermoplastics, we aim to reduce reliance on traditional metals while ensuring the structural integrity needed for launch and orbital conditions.
Thermoplastics offer key advantages, including **recyclability, cost-effective manufacturing**, and suitability for advanced techniques like thermoforming and over-molding. Our analysis focused on their application in **external panels and primary structural components** for small satellites, where weight reduction, manufacturability, and recyclability are critical.

A trade-off study evaluated **outgassing, chemical resistance, manufacturability, and cost**, leading to the selection of thermoplastics capable of meeting aerospace requirements. We developed and analyzed **three structural designs** using finite element simulations, assessing their performance under static loads, vibration, and modal analysis. The most promising design was then fabricated as a **small-scale PETG prototype** to test assembly and manufacturability, highlighting benefits like rapid prototyping and modularity.
The next phase involves producing a **full-scale demonstrator** using thermoforming to create lightweight, high-performance structures. This work showcases thermoplastics as a **viable, sustainable alternative** in satellite design, offering a pathway toward greener, cost-efficient space technology.

Keywords: Thermoplastics, Thermoforming, Over, molding, Modular design

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