IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Interactive Presentations - IAF MATERIALS AND STRUCTURES SYMPOSIUM (IP)

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FREE VIBRATIONS OF ULTRATHIN DEPLOYABLE BOOMS FABRICATED WITH NANO-MODIFIED EPOXY MATRIX

Abstract

Ultrathin deployable boom structures are currently investigated to increase the mission capacity of small spacecrafts within their limited package volume. The successful integration of boom technology would allow CubeSats to perform missions that are commonly reserved for larger and more complex space platforms. Deployable booms allow for placement of instrument and communication packages outside the satellite body, mimicking the behavior of large satellites. The dynamic characterization of boom structures during the deployment phase and in deployed configuration is of primary importance to understand the factors that influence the operative behavior of the entire satellite. For example, it is well known that booms start oscillating when crossing from the Earth's shadow into sunlight. This behavior is apparently induced by thermal gradients and is obviously undesirable. In recent years, the attention on selecting materials to control structural vibration during the design stage has increased. Polymer-based composites are a class of materials that have gained more attention for damping applications. The introduction of nanoparticles to the polymer matrix can add large benefits. Recent studies showed that nanocomposites possess a high potential for damping applications, reporting values of the damping factor in the range 200-400In the first part of this work, we fabricated prototypes of 1m-long self-deployable ultrathin booms with V-cross-section geometry using 1K carbon fiber reinforcement and epoxy resin modified with nanoparticles. In particular, we used nanosilica, single-walled carbon nanotubes (SWCNT), or graphene oxide (GO). The manufacturing process was studied and optimized in order to fabricate reproducible and reliable structures. Then, in order to investigate the effects of the nanoparticles on the vibrational response of the nanocomposite booms, we performed modal testing by impulsive excitation method. The vibrations of the boom structures were recorded using accelerometers positioned along the boom length. Natural frequencies and modal shapes were determined for each nanocomposite boom and compared with those of the equivalent fiber reinforced composite boom with unmodified epoxy resin.