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CARBON NANOTUBE EMBEDDED CFRP STRUCTURE FOR ELECTROMAGNETIC SHIELDING IN GHZ RANGE

Abstract

This research investigated the fabrication and test of a lightweight composite panel embedded with nanotechnology. The panel were developed by the Space Engineering Design Laboratory, at York University and supported by Canadian Space Agency (CSA). The objective of this study was to develop materials that are lighter than aluminum but have equivalent mechanical and EMI shielding properties. The developed composite panel was composed of two Carbon-Fiber-Reinforced-Polymer (CFRP) layers with an aluminum honeycomb core. The CFRP layers were embedded with carbon nanotubes (CNT) to enhance the mechanical and EMI shielding of CFRP. The aluminum honeycomb, alloy 5056 was bonded to the CFRP laminates made from M55J/RS-3 prepregs by an adhesive film, FM 300-2. The composite panel's unique strength and rigidity was attributed to the carbon fiber and aluminum honeycomb respectively. These features combined with cryogenic film used in bonding, made the panel not only strong and rigid, but also lightweight and able to withstand repeated temperature extremes.

The aptitude of the CNT embedded CFRP structure for EMI shielding and survivability in temperature extremes were characterized through a variety of tests. The EMI shielding effectiveness of the CFRP+CNT composites were measured via rectangular waveguides WR-229 (3.3-4.9GHz), WR-137 (5.5-8.5GHz), WR-90 (8.2-12.4GHz) and WR-62 (12.4-18.4GHz). The waveguides, connected to a network analyzer surrounded the samples. The EMI tests showed that panel absorbed up to 80dB in 3.3-18.4GHz frequency range.

The panel was subjected to extreme environmental testing in order to validate its use in a space structure. It was cycled from 200C to -170C for a total of ten times. This test characterized the properties of the adhesive film and the panel as a whole before and after the temperature cycling. The panel was heated in an oven to 200C at a rate faster than 10C/min. For the other end, the panel was cooled using liquid nitrogen and was submerged at -40C in order to induce thermal shocks. The mechanical bonding strength between the CFRP and honeycomb was characterized via a short beam test and bond face pull test. The results illustrated that the panel survived the extreme temperature cycles as well as the thermal shock from submerging it in the liquid nitrogen.