MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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Author: Mr. Fawad Tariq
Pakistan Space and Upper Atmosphere Research Commission (SUPARCO), Pakistan

Mr. Madni Shifa
Pakistan Space and Upper Atmosphere Research Commission (SUPARCO), Pakistan
Dr. Rasheed Ahmed Baloch
Pakistan Space and Upper Atmosphere Research Commission (SUPARCO), Pakistan

MULTIFUNCTIONAL CARBON NANOTUBES FILLED CARBON FIBER EPOXY COMPOSITE FOR SATELLITE STRUCTURAL APPLICATIONS

Abstract

Satellite has to operate in severe environment (i.e. vacuum, intense ultraviolet and ionizing radiations, thermal cycling, electrostatic discharge effects, debris impact, etc.) for years without failure during its life cycle. The choice of material for satellite structural applications therefore demands careful selection. In addition to various characteristics, material must be lightweight, mechanically strong and electrically conductive to guarantee reliable and uninterrupted performance in space. The use of carbon fiber reinforced composite (CFRP) is growing significantly in spacecraft industry because of their favorable properties. However, the prospective and capability of using carbon nanotubes (CNTs) as nano-fillers in CFRP for satellite structural application is still under research phase. Here we discuss the development and testing of multiscale CNT-filled CFRP material which exhibits good potential for use in satellite and spacecraft. Multiscale CNT-CFRP composite sheets were fabricated through compression molding technique in which 0.2%(by weight) CNTs were dispersed in epoxy matrix through bath sonication to make it electrically conductive. Electrical characteristics of multiscale composite were evaluated by performing dc electrical resistivity measurements and electromagnetic interference shielding effectiveness (EMI SE) test in 7-15 GHz frequency range. Mechanical performance of composite was also investigated by conducting tensile and flexural tests. Beside this, thermal stability was assessed by subjecting it to thermal cycling in range of -40°C to 120°C at ambient pressure. Electrical and mechanical properties of developed composite were compared with neat CFRP and aluminum alloy 6061 commonly used in satellite structures. Results demonstrated that the CNT-filled CFRP is electrically conductive (volume resistivity<100 ohm-cm) and can satisfactorily shield electromagnetic waves in wide frequency range due to addition of CNTs forming 3d conduction network. Further, the CNT-filled CFRP is about 50% lighter than aluminum alloy which means significant mass saving. The tensile strength of CNT-filled CFRP was twice the strength of 6061-T6 at similar tensile modulus level. The developed multiscale composite material offers host of benefits for satellite manufacturers and can possibly replace metallic counterparts specially in electronic housing.