MATERIALS AND STRUCTURES SYMPOSIUM (C2)
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DEVELOPMENT OF MULTI-FUNCTIONAL COMPOSITE STRUCTURES WITH EMBEDDED ELECTRONICS FOR SPACE APPLICATION

Abstract

This paper describes the effort to produce novel 'multi-functional structures' with the goal of flight hardware fabrication for space application in 'STSAT-3.' A conventional spacecraft structural function has been limited to supporting loads and mounting avionics only; whereas the emerging technology 'multi-functional structures' can integrate the thermal and electronic functions into their inherent load-bearing capability. In addition, they can provide the sufficient radiation shielding effectiveness for expected mission environment. By this concept, the ratio of electrical functionality to spacecraft volume can be dramatically increased and the significant mass savings can be obtained. In this paper, Spacecraft electronics are miniaturized by using advanced IT applications such as flexible circuitry, miniaturized components and feather-weight connectors and so on; thus they can be easily embedded within a structural panel. A sandwich structural panel consists of aluminum honeycomb-core and lightweight CFRP facesheets. Integration of electronics within the panel is implemented by mounting electronics on a multi-layered composite enclosure with multi materials. This composite enclosure provides the load-bearing, passive thermal conduction link, radiation shielding, EMI protection capabilities as well as available space for electronics to be embedded in the panel. The enclosure is incorporated within the composite panel by co-curing process for enhancement of structural integrity; the composite enclosure also can minimize the thermal deformation in the panel curing process. It can also provide the passive thermal conduction link with high thermal conductivity and transfer the heat from electronics to thermal radiative surface of spacecraft closure panel in order to dissipate it to space environment. The radiation shielding effectiveness of the composite enclosure is evaluated from the measurement of stopping and range of ions in material by the irradiation of proton and electron. The multi-functional composite panel contains the compact 'Telemetry Acquisition Unit' for on-orbit temperature and angular velocities measurement and 'GPS Receiver' for spacecraft position and time information. The electronics are implemented on the flexible circuitry and the power distribution and data transmission are made via the flexible printed wiring cables for elimination of conventional complex harness and connector configuration. A series of environmental tests and analyses will be discussed to demonstrate the flight hardware is qualified for the expected mission environments and the hardware design complies with the specified requirements.

This approach will be utilized for the advanced small satellite 'STSAT-3' to validate the multi-functional structures concept.