Paper ID: 43240
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IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures I - Development and Verification (Space Vehicles and Components) (1)

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DUAL TECHNOLOGY STRAIN GAUGE FOR ON-ORBIT SPACE STRUCTURES HEALTH MONITORING. CASE REPORT: TOP SEE

Abstract

Space structure engineers are faced with increasing requirements to extend the service life of manned space stations beyond their designed life cycles, resulting in heavy maintenance and inspection burdens as well as economic pressure. Structural health monitoring (SHM) is a new approach to meet safety and operational requirements especially in the above said conditions. We propose a coupled fail-safe/fault tolerant sensors system, combining different strain sensing technologies (fiber optic and carbon fiber,) used to read the same variables, so to improve the space modules structure monitoring. This double sensor system has been developed to provide existing and future spaceships with SHM capability due to its unique superior characteristics and reliability. This paper covers the aerospace SHM requirements and the results of the tests carried out, comparing the strain measured with the fiber optic sensor technologies to the strain as measured with a newly developed carbon fiber sensor. In particular, fiber Bragg grating (FBG) sensor technology and In-C sensor technologies are evaluated as the most promising tool for load monitoring and damage detection, the two critical SHM aspects of space structures. Optical fibers are almost immune to the EMC susceptibility. Carbon fiber sensors have never been used before as strain gauges but inexpensiveness, lightness, and the same sensitivity of the FBG (5 strain) show the potential of this new just patented technology that, combined with fiber optic sensors, gives a strong result in terms of measurement reliability and data significance. At last, in the paper the case report on the integration of this stand-alone sensor into a space structure is provided. The idea is to integrate the sensor within the spacecraft mechanical structure, avoiding any data connection with the space module data system and requiring only occasional power supply. A future development of energy harvesting is also highlighted. The proposed solution will allow a strong cost reduction, and significant power saving, also decreasing the software complexity, assuring a longer safe lifespan of the spaceships.