MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Specialized Technologies, including Nanotechnology (8)

Author: Dr. Antonios Vavouliotis
University of Patras, Greece

Mr. Athanasios Baltopoulos
University of Patras, Greece
Ms. Eleni Fiamegkou
Applied Mechanics Laboratory, Greece
Prof. Vassilis Kostopoulos
University of Patras, Greece
Dr. Thomas Rohr
European Space Agency (ESA), The Netherlands

NANO-MODIFICATION OF CYANATE ESTER COMPOSITES MATERIALS TOWARDS THE DEVELOPMENT OF NOVEL MATERIALS WITH TAILORED MECHANICAL, ELECTRICAL, THERMAL AND RF PROPERTIES FOR SPACE ANTENNA REFLECTOR APPLICATIONS

Abstract

This study is proposing a new strategy for meeting the high requirements of space antenna reflector applications by developing a new nano-modified CFRP material with inherent multi-functionality. The proposed material concept aims to solve current design drawbacks that the typical CFRPs are introducing so that, easier and cheaper fulfillment of the system requirements for high reflectivity and good thermo-elastic stability in complex shapes can be achieved. Initially the methodology for the incorporation of multi-wall carbon nanotubes in the cyanate ester system (Lonza, DT-4000) was investigated in order to achieve optimum nano-filler dispersion. For the developed materials, key properties such as electrical conductivity, thermal conductivity, thermo-gravimetric mass loss, glass transition temperature and elastic modulus/strength in bending were examined in comparison with reference system. The developed CNT-modified cyanate ester (CE) systems were used as matrix for the production of carbon fiber reinforced polymer (CFRP) composite materials. Special attention was invested on the development of a complete manufacturing protocol in order to overcome the challenging issues concerning the handling and processing of the nano-modified CE matrix. Quality screening methodologies were used (C-Scan, Optical and SEM) to verify the production. CFRP nanocomposites with CNT content of 0.5% wt. and 1% wt were produced and tested. The extensive characterization campaign included fracture properties (mode I, II and SBSS), electrical and thermal conductivity, thermo-elastic stability (thermal expansion coefficient), thermo-mechanical properties and electromagnetic properties (reflection and transmission coefficients). A significant reduction is recorded on the inherent anisotropy of the composites regarding thermo-elastic properties but also electrical and thermal conductivity. In parallel results showed that the nano-modification increased up to 50% the fracture energy (Gic, Giic). of the composites. Finally the EM tests of the novel composites indicate a marginal but not negligible increase (between 2-3dB) of the reflection coefficient. Under the scope that cyanate esters are highly engineered polymeric systems, already used and proven in space missions, the changes reported herein are considered extremely significant and encouraging for the establishment of a technology road map leading to the production of advanced nano-engineered materials and structures.