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DEVELOPMENT OF COMPOSITE MATERIALS BASED ON A CARBON NANOTUBES NETWORK FOR SPACE APPLICATIONS

Abstract

For few years, carbon nanotubes (CNTs) are included in various materials. As CNTs have high mechanical, thermal and electrical properties, it is expected to boost by adding CNTs the performances of the matrix material. Usually carbon nanotubes are used as additive to an organic matrix and in small quantities, below 1 wt%. In this work we develop composite materials with high amount of CNT, based on a carbon nanotubes network. The main type of CNT network manufactured and tested is buckypaper obtained by filtration of CNTs dispersed in a liquid solution. Other CNT networks like 3D preformed shape and CNT arrays have been also investigated. The potential improvement brought by adding CNT network to conventional materials has been evaluated using the engineering rules established for composites. Hence, the maximal achievable material properties have been estimated. Using the previously described analysis, the potential of CNT reinforced composite for different space applications have been ranked. The mechanical (mainly for CNT fibre) and thermal driven applications seem the most promising ones, especially if specific properties are considered (due to the low density of CNTs). On the basis of this evaluation and manufacturing technologies available in our consortium, experimental efforts have been put on the optimization of the CNT network mainly for improving its thermal performances. Influence of the CNTs characteristics on the macroscopic buckypaper properties has been evaluated with CNTs of different morphology (MWNT, DWNT), length and functionalization. Several process for manufacturing the buckypaper have been tried, using different solutions for CNTs dispersion (surfactant, water or ethanol), or applying alternative method like in-situ growth of CNTs on buckypapers. Among different CNT network post-treatment also tried, thermal treatment up to 2800C has given the greatest improvement on the specific thermal conductivity (multiplied by 3). Eventually the CNT network is infiltrated by an organic (epoxy) or inorganic (aluminium) matrix to make the composite. 3D shape CNT network gives highly reinforced composite with 30wt% of CNTs. Even if current properties of CNT reinforced composite materials are not yet competitive with reference aerospace materials, improvement potential is large and manufacturing technologies are growing.