Nano-fillers in fiber reinforced polymers for performance enhancement of satellite structures

S. Endler, L. Datashvili, H. Baier
Institute of Lightweight Structures (LLB), Technische Universität München, Germany
www.ll.mw.tum.de

For proper in orbit operation, satellite structures as those for communication and optical instruments have to achieve high functionality under severe environmental conditions. They have to be dimensionally very stable under quasi-static temperature changes and possibly also dynamic micro-excitations, they have to have good thermal and electrical conductivity and might even have to change their shape drastically in order to adapt to new mission requirements. To enhance such functionalities, the inclusion of smart materials to measure or enforce strains and the inclusion of nano materials to improve thermal and electrical conductivity and electromagnetic properties into the mostly carbon composite (CFRP) structures is considered. In this paper, the characterization and possible use of such materials will be presented.

Electrical and thermal conductivity of fiber reinforced polymers in fiber directions are often acceptable, while these properties should be improved in the other matrix dominated directions. So investigations are carried out for polymeric matrix materials enriched with different and partly significant volume fraction of CNTs to determine and improve thermal conductivity, temperature absorption and emission as well as the reflection behavior of electromagnetic waves. Results show that these properties can be significantly improved for proper types of fillers including their surface treatment.

Different types of fillers in combination with different types of polymer matrices are investigated. For example, alumina particles with and without surface functionalization are used in an epoxy matrix to improve their thermo-mechanical properties. In addition, electrical conductivity is enhanced too, which is also true for particles consisting of a mix of Carbon nanotubes together with Carbon black. The use of different types of particles in a silicone matrix shows that modifications of electrical conductivity is not necessarily highly correlated to those of other relevant properties such as electromagnetic reflectivity and passive intermodulation (PIM). While silver particles only very moderately modified electrical conductivity, reflectivity and PIM are significantly improved. Since the density of temperature induced micro-cracks can be usually also significantly reduced if not avoided in such materials especially with silicone polymer, such enriched polymers are also interesting options for functional surface coatings.