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Shape memory polymer composites with carbon nanotubes

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Nano-Materials Based Innovation

In the frame of the European Project SMARTFAN ("Smart by Design and Intelligent by Architecture for turbine blade fan and structural components systems", GA 760779), the University of Tor Vergata is developing shape memory composite structures for functional applications. Shape memory materials are able to recover a stored configuration by means of an external stimulus, typically thermal. Shape memory polymers (SMPs) are able to fix a deformed shape which is provided at a temperature over the transition temperature Tt when it is cooled under the same Tt. In a successive heating over Tt, the initial equilibrium configuration is recovered without any damage. SMPs can sustain several consecutive memory-recovery steps but loads have to be applied in each single memory step. In a thermosetting polymeric matrix composite (PMC), shape memory properties are typically given to the resin matrix as fibers do not show any important material transition. Therefore, in shape memory polymer composites (SMPCs) the transition temperature is the glass transition temperature of the resin matrix. In the last achievements, shape memory polymer composites (SMPCs) have been manufactured by using commercial PMC prepregs with SMP interlayers which are placed between adjacent uncured composite plies in the shape of powder. During laminate molding, prepreg cure and SMP polymerization occur contemporarily. In this study, carbon nanotubes (CNTs) have been integrated into the SMP interlayer by using a novel technique. The goal was to understand if the interaction of CNTs with the matrix could improve the SM behavior of the SMPC structure. The amount of CNT has been calculated to have 1 wt% in the SMP interlayer. Results show that the SMPC sample with CNTs in the SMP interlayer tends to behave in a more rigid way. It is a positive result in the case high actuation loads would be necessary. The best result has been obtained for the shape recovery as a value over 99% has been obtained for the first time on a SMPC laminate.

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