Improvement of delamination resistance of CFRC laminates using electrospun nanofibers interleaves

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Carbon fiber reinforced epoxies are widely used as structural materials in advanced applications, due to the combination of lightweight, high specific mechanical strength and excellent chemical resistance. One of the most common failure mechanisms of these materials is delamination. Over the years, several approaches have been followed in order to improve the delamination resistance, such as the modification of the epoxy matrix with the introduction of other components (elastomers [1,2], thermoplastics [3-4], nanofillers [2,5]). More recently, several papers are focused on an innovative toughening strategy based on the use of nanofibrous polymeric mats, produced by electrospinning, introduced in between the fabric plies of composite laminates. The toughening mechanism is due to the so called “Velcro effect”, based on multiple weak interactions, such as VdW forces and hydrogen bonds over the large nanofibers interfacial area [6,7]. Different polymers are used as electrospun interlayers (Nylon 6,6, Polysulfone, Polyacrylonitrile, etc.), and for the geometrical characteristics of the nanofibers and their membranes (nanofiber diameter, preferential vs. random alignment, mat thickness, etc.) different thermo-mechanical performances can be achieved.

This work presents the main results regarding the influence of electrospun mats on the thermo-mechanical properties of carbon fiber reinforced epoxy laminates and on the durability of such composite laminates under accelerated hydrothermal ageing. Both nylon 6,6 and rubber-thermoplastic hybrid mats were produced and used as interlayers. In particular for nylon 6,6 mats an increase of interlaminar shear strength up to 30% with respect to the neat composite is observed when these elements are placed at each interlayer. No detrimental effects on Tg and transversal flexural modulus are detected [8]. Interestingly, lower water uptake is observed for nylon 6,6 mat-modified laminates correlated to a reduced porosity, the mats probably acting as resin reservoirs with determine a more uniform distribution of the resin across the laminate upon curing.