INFLUENCE OF NANOFIBROUS MAT ON EPOXY RESIN UNDER TENSILE TEST AND DMTA

E. Poodts, R. Palazzetti and A. Zucchelli

Alma Mater Studiorum - University of Bologna
Department of Mechanical Engineering (DIEM)
viale Risorgimento 2, 40136 Bologna, Italy
e-mail: ezequiel.poodts4@unibo.it - Tel: +39 0512090474

Keywords: epoxy resin, nanofibers, electrospinning, mechanical tests.

Summary. Polymeric nanofibers are promising to significantly influence the developments of many fields in material science and engineering, and they lead the way into nanotechnology.

This work deals with nanofibers and their interaction with epoxy resin-based composite materials. For such kind of material, when subjected to impact and fatigue loads, delamination is often the dominating failure mode. Several methods have been developed over the years to enhance delamination resistance of laminates, like matrix toughening [1], optimization of stacking sequence [2, 3], laminate stitching [4], braiding [5], edge cap reinforcement [6], critical ply termination [7], and so on. Palazzetti et al. [8] successfully proposed to use a polymeric electrospun nanofibers interleave in composite laminates: the objective of the present study is to characterize a composite material made by epoxy resin reinforced with polymeric electrospun nanofibers. For this purpose, a modified VARTM (Vacuum Assisted Resin Transfer Molding) process has been implemented to manufacture 0.6 mm thick specimens where a layer of nanofibers is placed in the middle. Four different thicknesses are manufactured: 25, 50, 75 and 100 µm. Weight increasing is negligible due to the very low density of nanobifrous sheet. Epoxy resin and Nylon 6,6 provided by DuPont company are materials used in this work. Electrospun process is performed inside the laboratories of University of Bologna by a self-designed semi-automatic machine (see Figure 1). The VARTM process was performed using a closed mould (see Figure 2) and permitted to obtain dimensionally accurate specimens with no voids in them.

Figure 1. Electrospinning
Figure 2. Mould
Specimens were tested on tensile test and DMTA, performed to determine the effect of nanofibers on static and dynamic behavior of epoxy resin. From tensile tests, the tensile strength ($\sigma_{\text{max}}$) and the stiffness ($E$) were determined; storage ($E'$) and loss ($E''$) modulus were obtained from DMTA tests in order to calculate the dissipation factor ($\tan(\delta)$). Tests were performed on both virgin and nanoreinforced specimens, for each nanolayer thickness, and the results were compared.

It is shown that the presence of nanofibers significantly change the behavior of the specimen under the tests. In tensile, maximum load sensibly increased due to the nanofibers and no decrease in stiffness was registered. DMTA showed in important increase in damping factor for nanomodified specimens: it was observed that nanomodified resin is much more capable to store energy, compared to virgin one. Effect of nanolayer thickness was also discussed: for both the test it was observed that properties change proportionally to the nanofibrous thickness with a mixture-rule-like law.

References


