11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

Production of Tri-component Composites (Carbon fiber/Epoxy/Carbon nanotubes) by Resin Transfer Molding

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Abstract – In this work, resin transfer molding was used to produce tricomponent composites with epoxy, carbon fiber and different contents of MWNT (Multi-walled carbon nanotubes). The dispersion of MWNT in the epoxy resin was carried out using sonication. The tensile properties measured, show that the process of dispersion of the MWNT into epoxy and the RTM process are an alternative to produced hybrid composites.

Carbon fiber/epoxy composites are increasingly used for structural applications because of their excellent specific mechanical performance (mechanical properties/density) compared with conventional materials such as metals and ceramics [1]. To produce those composites, LCM processes (liquid composite molding) are becoming very popular. Among the LCM processes, resin transfer moulding (RTM) is believed to be an economical and efficient technique for the manufacturing of parts with complex shape. Nowadays, the use of carbon nanotubes in epoxy resin producing the so-called nanocomposites has been widely researched, with some surprising findings in a variety of properties such as mechanical, thermal and electric [2]. The main challenge in this area is to disperse the nanofillers so that they can transfer their properties to the composite.

In this work, resin transfer molding has been used to produce nanocomposites with the use of epoxy, carbon fiber and different contents of MWNT (Multi-walled carbon nanotubes). This three-phase composite has the potential to be used in many fields of applications, such as aerospace and defense. The dispersion of the MWNT in the epoxy resin was carried out using a sonication procedure. Flat plates with dimensions of $300 \times 300 \times 2$ mm were produced via radial RTM infiltration of plain weave carbon cloths (Figure 1). After curing, the composite was demoulded and samples were extracted for characterization. Three types of composites were produced: *5M* (carbon fiber/epoxy), *5M_25* (carbon fiber/epoxy/0.25% MWNT) and *5M_50* (carbon fiber/epoxy/0.50% MWNT) and the specimens were characterized via mechanical testing (tensile, impact and Barcol hardness). Table 1 presents the preliminary findings for the produced composites and a slight increase in tensile strength and Young's modulus may be seen for the 0.50% MWNT sample, demonstrating the potential of carbon nanotubes to reinforce resin-rich regions of the composites, between bundles of carbon fibers.

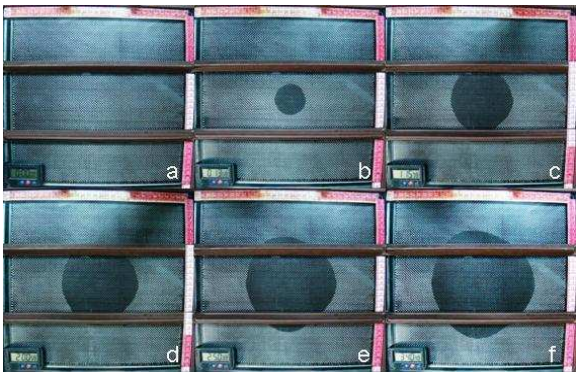

Figure 1: Sequence of images showing the progress of the flow front in a radial molding of the tri-component composite

Table 1: Properties found from the different composites.

Sample	Tensile Strength (MPa)	Young's Modulus (GPa)
5M	328 ± 23	32,4 ± 5.4
5M_25	320 ± 12	31,9 ± 1,9
5M_50	349 ± 17	34,1 ± 11.8

References

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[2] S.H. Pezzin, J. Suave, L.A.F. Coelho and S.C. Amico, Materials Science and Engineering A 509, 1-2 (2009) 57-62.