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Hygrothermal Ageing of Polypropylene/Maleated PP/Glass Fiber Composites: Influence of Compatibilizer Content and Fiber Sizing

Marcelo H. M. Dias [(1)] and J. Alexandrino Sousa[(1)*]

(1) Materials Engineering Department / Universidade Federal de São Carlos, e-mail: jasousa@ufscar.br
[1]* Corresponding author.

Abstract – 30 wt.% glass fiber (GF) reinforced polypropylene composites compatibilized with varying content of maleated PP were subjected to hygrothermal ageing in water at 80ºC, in order to investigate the influence of the polar compatibilizer´s content on the fiber-polymer interface integrity upon ageing. Injection molded tensile test specimen with two types of short GF treated with either PP compatible (P968) or polyamide compatible (P983) sizings were used. The relative tensile strength (TS) data of aged composites, normalized with respect to TS of PP matrix, clearly indicated an optimum compatibilizer content which minimizes the deterioration of this property with increasing ageing time.

Improved mechanical performance of short GF-reinforced PP composites can be achieved by the combined use of adequate coupling agents (aminosilanes) with a maleated-PP (PP-g-MAH) interfacial compatibilizer, in order to increase the fiber-polymer interfacial adhesion of this composite with a chemically inert and non-polar polymer matrix [1]. However, due to the introduction of polarity in both the matrix and the fiber-polymer interface through the addition of MAH molecules of the compatibilizer, it is important to monitor the integrity of the fiber-polymer interfacial adhesion against the erosive action of a hygrothermally active environment, in order to assure the long-term mechanical performance of these PP composites. Therefore, injection molded tensile test-specimen of 30 wt.% GF-reinforced PP composites with varying content of PP-g-MAH (0; 0,25; 0,5; 1; 2; 5 and 10 % wt) were subjected to hygrothermal ageing in water at 80 ºC for 24/48/120/240 hours. Two types of short GFs treated with either PP compatible (P968) or polyamide compatible (P983) sizings were used; both sizings incorporating essentially an aminosilane coupling agent.

In Figure 1, the relative tensile strength (TS) data of both aged and unaged P968 and P983 composites, normalized with respect to the TS of their corresponding aged/unaged PP matrices, is presented as a function of PP-g-MAH compatibilizer content at different ageing periods. Firstly, the relative TS curves of the unaged samples clearly show that the maximum GF-reinforcement efficiency is achieved at 2 and 10 wt.% compatibilizer content for the P968 and P983 composites respectively, which indicates that the optimum compatibilizer concentration (ϕ_{otm}) is reached when the entire fiber-polymer interface is saturated with PP-co-siloxane copolymer, as described in our previous work [2]. At a given ageing time, the loss in relative TS of P968 composites initially reduces with increasing PP-g-MAH content up to the ϕ_{otm} level, above which there is a gradual reduction in this property at higher compatibilizer content. Analyzing the ageing effect at the ϕ_{otm} compatibilizer content for the two types of GF sizings used, it becomes evident in Figure 2 that the deterioration in relative TS is much higher for the polyamide sized GF composites. Although the relative TS of both types of unaged PP composites attain nearly the same values at their ϕ_{otm} content, the hygrothermal ageing effect is much more pronounced for P983 composites due to the incompatibility of the polyamide GF sizing with the matrix PP molecules.

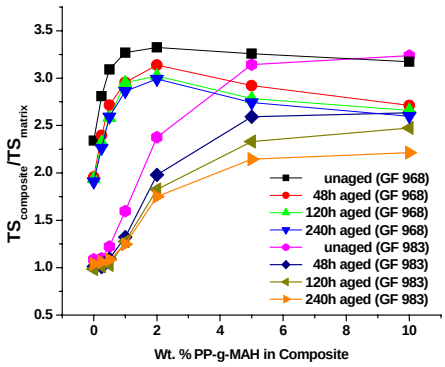

Figure 1: Relative tensile strength of aged and unaged PP/GF composites as a function of PP-g-MAH content.

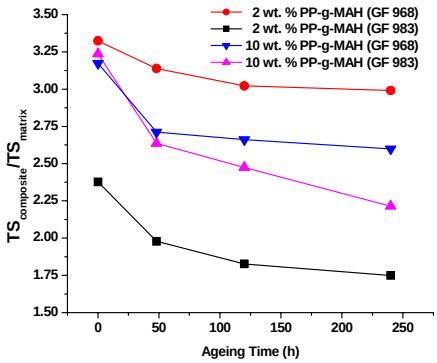

Figure 2: Relative tensile strength of aged and unaged PP/GF composites as a function of hygrothermal aging time.

[1] H. G. Karian, Handbook of Polypropylene and Polypropylene Composites, 2nd edn., Marcel Dekker, New York, 2003.
[2] P. E. Lopes; J. A. Sousa, "Influence of PP-g-MAH Compatibilizer Characteristics on Interphase and Mechanical Properties of Glass Fiber Reinforced Polypropylene Composites", Proceedings (CD-ROM) of 18th Annual Meeting of Polymer Processing Society, Paper 496, 9 pg., Guimarães - Portugal, June (2002).