11th International Conference
on Advanced Materials

ICAM2009

Rio de Janeiro Brazil
September 20 - 25

Adhesion Evaluation of Carbon Fiber/PPS and Carbon Fiber/PI/PPS Composites by Using ILSS Test

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Abstract – Three different types of carbon fiber and PPS composites were compared by using ILSS test. The ILSS results show that PI influence the composite interface, improving the adhesion between the carbon fiber and PPS.

Carbon fabric reinforced thermoplastic composites are presenting an increasing application on modern aircrafts in recent years. Their common advantages include not only similar or higher mechanical properties than metallic materials, such as specific modulus and strength, fatigue strength and corrosion resistance, but also better characteristics when compared with thermosetting matrix, namely, unlimited shelf life, recyclability, cost effective processing and excellent toughness [1-3].

The PPS (polyphenylene sulphide) have been studied as a matrix in thermoplastic composite materials due to present a high performance polymer with processing temperature associated with good mechanical properties principally when reinforced with continuous fibers. Poly(phenylene sulphide) is a highly crystalline polymer (range of 50-60%) with appreciate combination of properties, like chemical and fire resistances and thermal stability. It's also an excellent corrosion resistance, to its inertness to organic solvents, inorganic salts, and bases [4-8].

However, the union of two different materials to produce a composite one has been shown to depend on their interfacial adhesion, between fiber and matrix, to ensure a good performance and durability. Modification on composite interphase is a known way to improve its interlaminar shear strength, for example. This is a recent application for high performance PI (polyimide), as interphase in high performance thermoplastic composites, by use of its precursor, the PAA (polyamic acid), in order to improve the mechanical properties depending on the interfacial adhesion [9,10].

The aim of the present work was to evaluate the interfacial adhesion of PPS/carbon fiber composites, by using ILSS mechanical test. In order to achieve this study, three different types of carbon fiber composites were compared: 1) supplied with carbon fiber and PPS by the Tencate Company from Netherlands (as received); 2) obtained by using PMDA/p-PDA-PI coating in carbon fiber and PPS and 3) obtained by using of aqueous suspension prepregging process with PMDA/p-PDA polyamic acid, carbon fiber and PPS. In this last technique, PPS and PAA matrixes are deposited simultaneously on the reinforcement during the impregnation, and then, the PAA is thermally converted in a PI, forming an interphase region between the reinforcement and the polymer matrix.

The ILSS results of the carbon fiber/PPS and PMDA/p-PDA-PI coating/carbon fiber/PPS composites show the ILSS values of 58,4 and 60,0 MPa, respectively, showing the superiority of adhesion between the PI and carbon fiber when compared with the traditional PPS/carbon fiber laminate. When evaluated by optical microscopy, could be observed that both composites exhibit delaminations with interlaminar cracks, characterized for parallel failure, and vertical positions. However, there are evidences of flexural fractures, with a small bended of specimens or failures in the surface that covers the material in the normal direction to the lamination. In this moment, the carbon fiber/PI/carbon fiber laminate produced by aqueous suspension is being evaluated by ILSS test and the preliminary results shows that the PI formed an interfacial region that improved the adhesion between the carbon fiber and PPS.

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