World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:11, No:05, 2017

Topographic and Thermal Analysis of Plasma Polymer Coated Hybrid Fibers for Composite Applications

Authors : Hande Yavuz, Grégory Girard, Jinbo Bai

Abstract : Manufacturing of hybrid composites requires particular attention to overcome various critical weaknesses that are originated from poor interfacial compatibility. A large number of parameters have to be considered to optimize the interfacial bond strength either to avoid flaw sensitivity or delamination that occurs in composites. For this reason, surface characterization of reinforcement phase is needed in order to provide necessary data to drive an assessment of fiber-matrix interfacial compatibility prior to fabrication of composite structures. Compared to conventional plasma polymerization processes such as radiofrequency and microwave, dielectric barrier discharge assisted plasma polymerization is a promising process that can be utilized to modify the surface properties of carbon fibers in a continuous manner. Finding the most suitable conditions (e.g., plasma power, plasma duration, precursor proportion) for plasma polymerization of pyrrole in post-discharge region either in the presence or in the absence of p-toluene sulfonic acid monohydrate as well as the characterization of plasma polypyrrole coated fibers are the important aspects of this work. Throughout the current investigation, atomic force microscopy (AFM) and thermogravimetric analysis (TGA) are used to characterize plasma treated hybrid fibers (CNT-grafted Toray T700-12K carbon fibers, referred as T700/CNT). TGA results show the trend in the change of decomposition process of deposited polymer on fibers as a function of temperature up to 900 °C. Within the same period of time, all plasma pyrrole treated samples began to lose weight with relatively fast rate up to 400 °C which suggests the loss of polymeric structures. The weight loss between 300 and 600 °C is attributed to evolution of CO2 due to decomposition of functional groups (e.g. carboxyl compounds). With keeping in mind the surface chemical structure, the higher the amount of carbonyl, alcohols, and ether compounds, the lower the stability of deposited polymer. Thus, the highest weight loss is observed in 1400 W 45 s pyrrole+pTSA.H2O plasma treated sample probably because of the presence of less stable polymer than that of other plasma treated samples. Comparison of the AFM images for untreated and plasma treated samples shows that the surface topography may change on a microscopic scale. The AFM image of 1800 W 45 s treated T700/CNT fiber possesses the most significant increase in roughening compared to untreated T700/CNT fiber. Namely, the fiber surface became rougher with ~3.6 fold that of the T700/CNT fiber. The increase observed in surface roughness compared to untreated T700/CNT fiber may provide more contact points between fiber and matrix due to increased surface area. It is believed to be beneficial for their application as reinforcement in composites.

Keywords : hybrid fibers, surface characterization, surface roughness, thermal stability
Conference Title : ICPC 2017 : International Conference on Polymers and Composites
Conference Location : Paris, France
Conference Dates : May 18-19, 2017