Accepted Manuscript

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PII: S1359-8368(17)32525-8

DOI: 10.1016/j.compositesb.2017.12.013

Reference: JCOMB 5442

To appear in: *Composites Part B*

Received Date: 26 July 2017

Revised Date: 8 December 2017

Accepted Date: 15 December 2017

Please cite this article as: Ulus H, Kaybal HB, Eskizeybek V, Sahin ÖS, Avcı A, Static and dynamic mechanical responses of $CaCO_3$ nanoparticle modified epoxy/carbon fiber nanocomposites, *Composites Part B* (2018), doi: 10.1016/j.compositesb.2017.12.013.

Static and dynamic mechanical responses of $CaCO_3$ nanoparticle modified epoxy/carbon fiber nanocomposites

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Abstract

Matrix modification of carbon fiber reinforced polymer composites with nanoparticles is an effective way to improve its matrix dominated properties. After nanoparticle modification, understanding mechanical properties is important in structural applications, and improvement of such properties can lead to the usage in the wider fields. This study aimed to investigate experimentally static and dynamic mechanical behaviors of $CaCO_3$ modified epoxy/carbon fiber nanocomposites. For this, we filled various amounts of $CaCO_3$ nanoreinforcements into the epoxy matrix, and the nanoreinforced epoxy was used to impregnate carbon fabrics (CF) by utilizing vacuum assisted resin infusion method (VARIM). The prepared fiber reinforced nanocomposites were subjected to tensile, bending and low velocity impact loadings. As a result of all experiments, the tensile strength of CF/epoxy nanocomposites increased about 48% with the addition of 2 wt.% $CaCO_3$ nanoreinforcement. The flexural strength enhancements were also determined as 47% for the same $CaCO_3$ nanoreinforcement loading. Besides, by utilizing low-velocity impact tests, we revealed that the $CaCO_3$ nanoparticle reinforced CF/epoxy nanocomposites exhibited higher impact performances compared to neat CF/epoxy composites. The resulting fracture morphologies were examined by electron microscopy to disclose related mechanical toughening mechanisms. Based on the morphological analysis, crack pinning, crack deflection and debonding of nanoparticles were the primary reasons leading to the improvement of toughness. The authors concluded that the addition of the $CaCO_3$ nanoreinforcements in CF/epoxy composites has significantly influenced the mechanical and physical properties of the nanocomposites.

Keywords: Calcium carbonate ($CaCO_3$), nanoreinforcement, carbon fiber, toughness, mechanical test

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