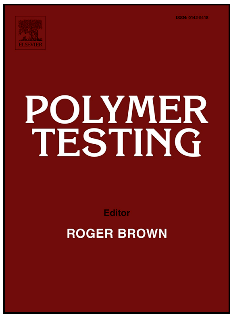

Impact resistance of hybrid glass fiber reinforced epoxy/nanoclay composite

Ahmad Rafiq, Nesar Merah, Rachid Boukhili, Muneer Al-Qadhi

PII: S0142-9418(16)30853-4

DOI: 10.1016/j.polymertesting.2016.11.005

Reference: POTE 4821

To appear in: *Polymer Testing*

Received Date: 31 August 2016

Revised Date: 30 October 2016

Accepted Date: 4 November 2016

Impact Resistance of Hybrid Glass Fiber Reinforced Epoxy/Nanoclay Composite

Ahmad Rafiq[a,1], Nesar Merah[a,2], Rachid Boukhili[b,3], and Muneer Al-Qadhi[a,4].

[a]*Department of Mechanical Engineering, King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia, 31261,*
[b]*Department of Mechanical Engineering, École Polytechnique P.O. Box 6079, Station Centre Ville, Montréal, Qc, Canada, H3C 3A7*

[1]ahmadrafiq90@gmail.com, [2]nesar@kfupm.edu.sa, [3]rachid.boukhili@polymtl.ca, [4]alqadhi@kfupm.edu.sa

Abstract. The effect of nanoclay addition in Glass Fiber Reinforced Epoxy (GFRE) composites on impact response was studied. The epoxy nanocomposite matrix with 1.5 and 3.0 wt% loading of I.30E nanoclay was produced by high shear mixing. Hybrid GFRE nanoclay composite plates were manufactured by hand layup and hot pressing techniques using electrical grade-corrosion resistant (E-CR) glass fiber mats. The laminates were then subjected to low-velocity impact with energies between 10 and 50 J. Addition of nanoclay was found to improve peak load and stiffness of GFRE. Nanoclay loading of 1.5 wt% resulted in optimum properties, with 23% improvement in peak load and 11% increase in stiffness. A significant reduction in physical damage was also observed for hybrid nanocomposite samples as compared to GFRE. This was mainly attributed to transition in damage mechanism due to nanoclay addition. Clay agglomeration in samples with 3.0wt% loading contributed towards limiting the improvement in impact resistance.

Keywords: Impact Testing, Nanocomposites, Hybrid composites, Epoxy, Nanoclay, GFR.

Introduction

Impact resistance is of considerable importance for laminated fiber composites as they, being inherently brittle, undergo subsurface damage like delamination, matrix cracking and fiber fracture. These damages are usually present even when there is no visible effect of impact on the surface of the laminated composites. The impact situations are potentially present during service-life in many forms, such as tool drops, hailstorms and ballistic loadings etc. Additionally, these laminates have very poor mechanical properties in the through-the-thickness direction. Low velocity impact is potentially more dangerous as the contact duration is long enough for the entire structure to respond and can initiate undetected subsurface cracks that can cause sudden failure [1].

Addition of nanoclay as a filler has attracted a lot of attention as it enhances mechanical and barrier properties of polymer composites. These nanocomposites also find specific use in areas such as piping industry due to the improvement in mechanical properties and the improved resistance to water uptake [2-5]. For fiber reinforced composites, the improvement depends largely on the type of epoxy system, fibers, nano fillers and the processing techniques [6-11]. During fabrication of fiber reinforced polymer composites the clay is first mixed with epoxy system using different methods such as mechanical stirring, high shear mixing and ultra-