World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:9, No:10, 2015

Interface Fracture of Sandwich Composite Influenced by Multiwalled Carbon Nanotube

Authors : Alak Kumar Patra, Nilanjan Mitra

Abstract : Higher strength to weight ratio is the main advantage of sandwich composite structures. Interfacial delamination between the face sheet and core is a major problem in these structures. Many research works are devoted to improve the interfacial fracture toughness of composites majorities of which are on nano and laminated composites. Work on influence of multiwalled carbon nano-tubes (MWCNT) dispersed resin system on interface fracture of glass-epoxy PVC core sandwich composite is extremely limited. Finite element study is followed by experimental investigation on interface fracture toughness of glass-epoxy (G/E) PVC core sandwich composite with and without MWCNT. Results demonstrate an improvement in interface fracture toughness values (Gc) of samples with a certain percentages of MWCNT. In addition, dispersion of MWCNT in epoxy resin through sonication followed by mixing of hardener and vacuum resin infusion (VRI) technology used in this study is an easy and cost effective methodology in comparison to previously adopted other methods limited to laminated composites. The study also identifies the optimum weight percentage of MWCNT addition in the resin system for maximum performance gain in interfacial fracture toughness. The results agree with finite element study, high-resolution transmission electron microscope (HRTEM) analysis and fracture micrograph of field emission scanning electron microscope (FESEM) investigation. Interface fracture toughness (GC) of the DCB sandwich samples is calculated using the compliance calibration (CC) method considering the modification due to shear. Compliance (C) vs. crack length (a) data of modified sandwich DCB specimen is fitted to a power function of crack length. The calculated mean value of the exponent n from the plots of experimental results is 2.22 and is different from the value (n=3) prescribed in ASTM D5528-01for mode 1 fracture toughness of laminate composites (which is the basis for modified compliance calibration method). Differentiating C with respect to crack length (a) and substituting it in the expression GC provides its value. The research demonstrates improvement of 14.4% in peak load carrying capacity and 34.34% in interface fracture toughness GC for samples with 1.5 wt% MWCNT (weight % being taken with respect to weight of resin) in comparison to samples without MWCNT. The paper focuses on significant improvement in experimentally determined interface fracture toughness of sandwich samples with MWCNT over the samples without MWCNT using much simpler method of sonication. Good dispersion of MWCNT was observed in HRTEM with 1.5 wt% MWCNT addition in comparison to other percentages of MWCNT. FESEM studies have also demonstrated good dispersion and fiber bridging of MWCNT in resin system. Ductility is also observed to be higher for samples with MWCNT in comparison to samples without.

Keywords : carbon nanotube, epoxy resin, foam, glass fibers, interfacial fracture, sandwich composite
Conference Title : ICCM 2015 : International Conference on Composite Materials
Conference Location : London, United Kingdom
Conference Dates : October 23-24, 2015