IMPACT AND COMPRESSION AFTER IMPACT (CAI) PROPERTIES OF CARBON NANOCOMPOSITES

K.Vrettos, C. Kostagiannakopoulou, G. Sotiriadis, V. Kostopoulos*
Department of Mechanical Engineering and Aeronautics, University of Patras,
University Campus, GR-26504 Rio Patras, Greece
*corresponding author, tel. +302610969441, fax. +302610969417
e-mail: kostopoulos@mech.upatras.gr

Due to their high specific strength and stiffness, Fiber Reinforced Polymers are of increasingly demand as structural materials not only in the weight-sensitive aerospace and aeronautic industries, but also in automotive, marine, armor and sporting goods industries. However, the poor out-of-plane performance of composites has acted as a barrier for extending their use in further applications.
Epoxy resin is the most commonly used polymer matrix for advanced composite materials. A considerable amount of research has been conducted regarding the toughening of epoxy resins to enhance the interlaminar fracture toughness and generally the damage tolerance of CFRPs. In the past decade, the incorporation of nanoparticles [1, 2] into the epoxy matrices offers new possibilities toward this direction.

The goal of the present study was to investigate the influence of multi-walled carbon nanotubes (MCNTs) and different types of graphene nanoplatelets (GNPs) on the impact behavior of carbon fiber reinforced polymer (CFRP) laminates. The material used as a matrix in this study was a four-part/component prepreg epoxy system, provided by Huntsman Advanced Materials (Switzerland). Two types of GNPs were used, GNPs 4L that were provided by Cheap Tubes Inc. (USA) and GNPs XL supplied by NanoInnova Technologies (Spain). Furthermore, the MWCNTs were purchased from Arkema (France) while the reinforcement phase, a 200 g/m^2 UD non-crimp fabric, provided from TORAYCA (Japan).

The incorporation of fillers into the used industrial prepreg epoxy system was succeeded by using a three-roll mill technique. Following the above process three different types of carbon-modified blends in content of 0.5%wt. were developed. The prepared mixtures were used for the impregnation of unidirectional fabrics with a purpose of producing nano-modified pre-impregnated layers according to the inhouse prepregging technique. The produced materials were cured in an autoclave in a curing and pressure profile according to manufacturer.
Low velocity Impact and CAI tests were performed according to Airbus standard AITM1-0010 to study the impact properties of developed multi-scale CFRP laminates.
Three samples of each material configuration were tested, and the applied impact energies were 8,15 25 Joule.

The results indicate that the presence of fillers into the epoxy matrix of CFRPs improved their CAI properties. Finally, it is worth mentioning that MWCNTs proved more promising nano-fillers in comparison with GNPs for improving the impact behavior of CFRPs.

References

[1] Kostopoulos, V., Baltopoulos, A., Karapappas, P.,Vavouliotis, A., Paipetis, A., “Impact and after-impact properties of carbon fibre reinforced composites enhanced with multi-wall carbon nanotubes,” Compos. Sci. and Technology 70(4), 553–563 (2010)

[2] Mannov , E., Schmutzler , H., Chandrasekaran , S., Viets , C., Buschhorn , S., Tölle , F., Mülhaupt, R., and Schulte, K., “Improvement of compressive strength after impact in fibre reinforced polymer composites by matrix modification with thermally reduced graphene oxide ,” Compos. Sci. and Technology 87, 39–41 (2013)