Carbon Nanotubes applied to adhesion science: Single-lap joint case study investigation

Monteiro E.C.[1,*,elviscm2014.ufmg@outlook.com], Avila. A.F[2]

[1] Mechanical Engineering Graduate Studies Program, Laboratory of Composite Materials, Department of Mechanical Engineering, UFMG, Belo Horizonte, Brazil.
[2] Laboratory of Composite Materials, Department of Mechanical Engineering, UFMG, Belo Horizonte, Brazil.

This study investigates the influence of the adhesive (epoxy) thickness and the dispersions of carbon based nanostructures (carbon nanotubes – CNT) on mechanical properties of single-lap bonded joints. To achieve this goal, three CNT concentrations: 0.5%, 1.0% and 2.0% by weight; and three different thicknesses: 0.05mm, 0.15 mm and 0.4 mm were evaluated. The mechanical properties were measured using the apparent shear tensile test, based on ASTM D5868. The adherents were made using a woven glass fibers and an epoxy resin with the ratio of 60% of fiber and 40% of resin. The nanostructures was dispersed in the epoxy resin using an ultrasonic bath for 80 min. The single-lap joints were cured for 24 hours at room temperature and the post-cure was performed for 6 hours at 80°C. The results showed a significant change in failure mode observed in the broken joints. Apparently the addition of nanotubes promoted the development of a stronger interface, as evidenced by the increase in the intensity of the damage observed in the failure regions. Failure migrated from a mixed form of adhesive failure and LFT (light-fiber tear) to a purely LFT type with high degree of damage on the adhered fibers, as can be seen in the groups that received 1.0% and 2.0% carbon nanotubes. The reduction (from 0.4 mm to 0.15 mm) in thickness influences the load capacity, causing an increase up to 57.12% on final strength of the joint, this fact was observed in the group with addition of 1.0% CNT. The addition of nanotubes promoted an increase on adhesive strength up to 10% and maximum displacement up to 16.8%, observed in specimens with thickness of 0.15 mm. The results can be attributed to the CNT's distributions inside adhesive. Optical microscopy analysis of failure surfaces revealed CNT cluster formation. A more comprehensive analysis (SEM/AFM) in underway.