Non-covalent Functionalization of Carbon Based Nanostructures and Its Application to Carbon/Epoxy Composites

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Abstract

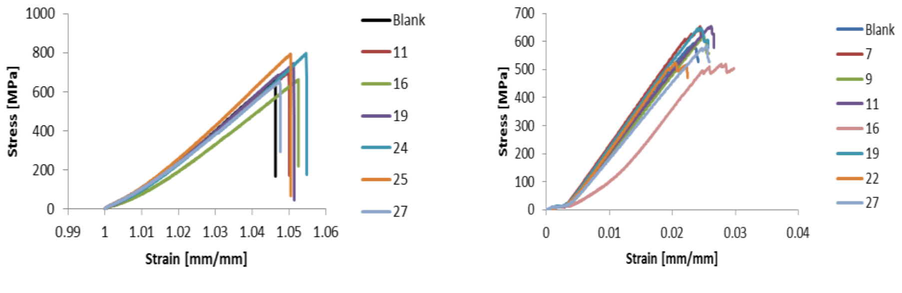
The purpose of this research is to investigate the effect of non-covalent functionalization by the usage of surfactant addition on carbon/epoxy composites nano-modified by carbon nanotubes (MWCNT) and graphene (MLG). To achieve this goal, a series of 36 hybrid composite materials were prepared, tested and analyzed. The amount of MWCNT and MLG employed in this research were 0.15% wt and 0.30% wt. The surfactants (Polyoxyethylene (40) nonylphenyl ether - IGEPAL® CO-890 and Sodium dodecylbenzenesulfonate - SDBS) were selected based on Tkalya et al. [1] results. AS described by Lee et al. [2], the tensile test follows the ASTM D3039 standard, while the three point bending test followed the ASTM D790 standard. The macroscopic analysis based on bending and tensile tests were analyzed first. Stiffness and strength were the two key parameters evaluated. When the carbon/epoxy nano-modified composite macro mechanical behavior is analyzed some comments can be drawn. First, the usage on ionic surfactants (SDBS), which is commonly used to disperse carbon nanotubes, has no significant effect into the CNT-epoxy system interaction. On the other hand, the non-ionic surfactant (CO890) seems to be effective to the graphene-epoxy and/or the graphene-CNT-epoxy systems. Based on tensile tests (Fig. 1A) and increase on stiffness around 9.45% was observed due to the usage of CO890 and MLG in addition to the pristine MWNT. A much higher increase was detected on ultimate strength, i.e. 23.49%. For the bending analysis (Fig. 1B), no significant change on flexural stiffness was observed; in fact for some groups (27 and 33) a decrease was detected. An average increase on bending ultimate strength of approximately 11.44% was notice for the specimens with MLG+CO890 and pristine MWNT (group 19). Again the linkage by tail for graphene and head for carbon nanotube can be the reason for such behavior. Note that Figures 2A-B show the nanostructures dispersion in a three-dimensional for samples from group 25 and 19, respectively. These nanostructures seem to provide the extra grip for energy dissipation and the increase on ultimate strength for tensile and bending tests.

References

[1] Tkalya, E., Ghislandi, M., de With, G., Koning, C.E. *Current Opinion in Colloid & Interface Science*, **17** (2012) 225.

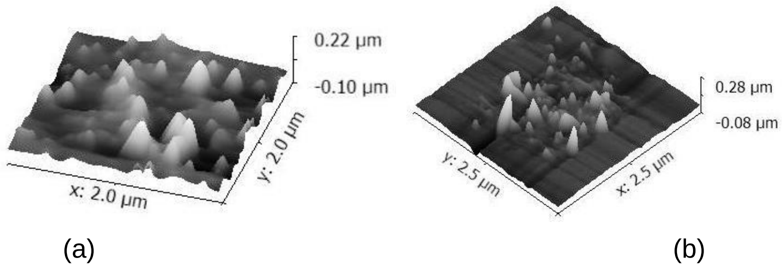
[2] Lee, S.H., Lee, D.H., Lee, W.J. and Kim, S.D., *Advanced Functional Materials*, **21** (2011), 1338.

Figures



(a) (b)

Figure 1. Stress-strain curves. (a) Tensile; (b) Bending



(a) (b)

Figure 2. AFM representation (a) sample from Group 25; (b) sample from Group 19