The influence of curing agents in the impact properties of epoxy resin nanocomposites

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This study investigates the impact properties (impact strength (IS) and impact energy (IE)) of epoxy resin nanocomposites (EPNCs) manufactured with different curing agents and reinforced with alumina nanoparticles (NPs). The NPs consisted on alpha alumina with irregular shapes (100 nm maximum size) pretreated with a silane agent. The weight fractions of alumina NPs were 1, 3 and 5 wt(%). Two different epoxy (EP) resins were studied and compared. The first one was cured and post cured with bis (4- aminophenyl) methane (DDM) and the second one was cured with 3-Dodec-2- enyloxolane-2, 5-dione (DDSA) + 8-methyl-3a, 4, 7, 7a-tetrahydro-4, 7-methano-2-benzofuran-1, 3-dione (MNA). Comparatively to the neat EP, and among the three NPs loadings used in this study, the EPNCs with 1 wt(%) showed the maximum improvement in IS and IE, around 78%(IE)-89%(IS) for DDM and 82%(IS)-93%(IE) for DDSA + MNA. EPNCs with 1 wt(%) cured with DDM present the best results for IS and IE, when compared with EPNCs cured with DDSA + MNA. IS and IE of EPNCs highly reduce at 3–5 wt(%).

Main Conclusions

This article presented an experimental study on the reinforcing effects of pretreated alpha alumina NPs (with non-spherical shapes and with 100 nm maximum size) used as nanofillers in EP resins. The impact properties of EPNCs cured with DDSA + MNA and DDM curing agents, namely IS and IE, were studied. The two different EP resin matrices were filled with three different weight fractions of alumina NPs: 1, 3 and 5 wt(%). From the obtained results, the following conclusions can be drawn:

- Among the three NPs loadings considered in this study, maximum values for the IS and IE of the tested EPNCs were observed for 1 wt(%) content of alumina NPs. The increase is around 82% (IS)-93%(IE) for DDSA + MNA and 78%(IE)-89%(IS) for DDM, in comparison with the neat samples;
- For percentage loading above 1 wt(%), namely for 3 wt(%) and 5 wt(%), IS and IE decreases as the percentage loading of alumina NPs increases. For the thermoset system cured with DDM, the decrease is around ?57% at 3 wt(%) and ?42% at 5 wt(%) loading of alumina NPs, with respect to the neat samples. For the thermoset system cured with DDSA + MNA and for 3–5 wt(%), the IS and the IE does not change significantly in comparison with the neat samples;
- Although the thermoset system cured with DDM presents the best results for the impact performance at the critical percent-age loading of NPs, when compared with the thermoset system cured with DDSA + MNA, the improvement is not very high. For this reason, and since for the curing agent DDSA + MNA no post- cure is required, the use of DDSA + MNA can be a good option in terms of thermoset manufacture.

Keywords

Nanocomposites; Impact behavior; Mechanical testing; Cure

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