EXPANDED GRAPHITE AND ITS DERIVATIVES AS MODIFIER OF PROPERTIES OF THERMOPLASTIC POLYURETHANES

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ABSTRACT

To increase the performance of polymeric materials the addition of nanofillers is a widely used tool. We analysed the effect of expanded graphite (EG), graphite oxide (GO) and their derivatives on the mechanical, electrical and thermal properties of thermoplastic polyurethane.

Heavily oxidized and ordered graphene nanoplatelets with more than 30 atom % oxygen were produced from natural graphite by an oxidation method proposed by Marcano et al.[1] The oxygen functionalities include hydroxyls, epoxides, carbonyl and carboxylic groups. The GO produced has still intact basal planes and remain in a layered structure with interlayer distance of ca. 0.8 nm. GO was treated with MDI to produce isocyanate functional sites grafted to the oxygen functionalities present on the graphite oxide. This introduction of bulky functional groups widens the interlayer distance to 1.3 nm in these isocyanate modified graphite oxide (iGO).

The high oxygen content in GO is accompanied by sp^3 defects and results in very low electrical conductivity. To improve the conductivity, reduction of GO was studied. Beside thermal reduction, which is connected with a big loss in material yield, a benzyl alcohol mediated reduction process was found to be highly effective in defect repair; the conductivity of the reduced graphite oxide (RGO) increased 9 orders of magnitude compared to GO. Thermal reduction results in sudden decomposition of the oxygen functional groups and eventually partial exfoliation occurred. There is a strong influence of the temperature on the reduction degree.

The EG and EG derivatives were used in the preparation in TPU composites by in-situ polymerization followed by melt processing and compression moulding. Young's modulus, tensile strength and elongation at break can be improved by addition of GO and iGO. RGO addition shows only a small effect on these properties, while EG addition deteriorates the mechanical properties of TPU. However, electrical conductivity can be reached only by EG addition. Despite the rather high conductivity of RGO electrical percolation was not reached with this filler type.

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References:

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