POLYOLEFINS – POLYHEDRAL OLIGOMERIC SILSESQUIOXANES (POSS) NANOCOMPOSITES: MECHANICAL PROPERTIES, MORPHOLOGY AND THERMAL BEHAVIOUR

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Abstract
The structure and phase behaviour of PP/POSS and PE/POSS nanocomposites obtained by reactive blending have been investigated. Tensile and impact experiments, SEM, SAXS, WAXS and DSC demonstrated marked changes in the crystallization behaviour and properties of the samples, indicating a molecular dispersion of the POSS filler.

1 Introduction

In the field of inorganic-organic composite materials, many research interests are oriented to polyhedral oligomeric silsesquioxane (POSS) based materials, both as organic-inorganic hybrids and as polymer nanocomposites. POSS's make a family of compounds with general formula $(RSiO_{1,5})_p$ where R is hydrogen or an organic group (alkyl, aryl or any of their derivatives), and are characterized by a size in the range 1-3 nm and by high chemical versatility and capability to form nanostructures with tailored dimensionality.[1,2] The good dispersion of POSS nanoparticles in several polymeric matrices - such as polyacrylates, polyesters, polyimides, polystyrene and its copolymers - allowed to obtain advanced composite materials with high thermal, mechanical and oxidative performances [2,3]. The compatibility of POSS with polymers is expected to be markedly enhanced due to the possibility of modifying the chemical/physical interactions at polymer-filler interface through introduction of functional groups on the POSS molecules.

2 Materials and testing methods

In this work we focus on preparation, structure and morphological characterization as well as mechanical and thermal performance of PP/POSS and PE/POSS hybrids obtained by POSS grafting on PP or PE chains during a reactive blending of polypropylene (iPP), maleic anhydride functionalized PP (PP-g-MA) and differently modified POSS aminopropylisobutyl-POSS, aminopropylisooctyl-POSS and aminoethylaminopropylisobutyl-POSS) as well as polyethylene (HDPE), maleic anhydride functionalized PE (HDPE-g-MA) and the above-mentioned POSS, taking advantage of the high efficiency of amino-anhydride reaction in the molten state (Fig. 1).

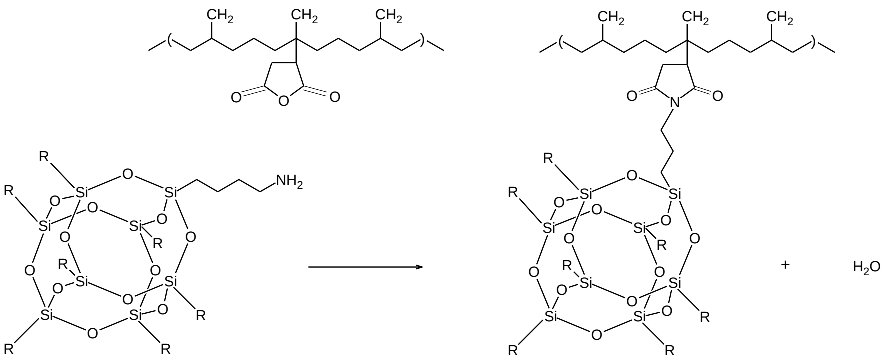

Figure 1. Melt grafting of NH_2-POSS onto PP-g-MA.

The structure, morphology and physical properties of the obtained composites and hybrids were studied by means of various techniques, including wide- and small angle X-ray scattering, calorimetry, scanning electron microscopy, DMTA, tensile and impact experiments. The influence of POSS structure and grafting degree on the morphological characteristics and mechanical properties was investigated.

3 Results and conclusions

It was found that in PP/POSS hybrids obtained by grafting of POSS cages on malenated PP or PE chains leads to the POSS dispersion on the molecular level. In contrary, in samples of aminopropylisobutyl-POSS was blended with plain iPP or HDPE any grafting of POSS on polymer chains was impossible, which resulted in phase separation and formation of crystallites of POSS dispersed in iPP or HDPE matrix. The mechanical tests revealed that modification of polypropylene by grafting with POSS molecules does not affect significantly its mechanical properties, both static and dynamic (Fig.2). Likewise, the impact properties of PP were not improved by modification with POSS.

Also in the case of PE/POSS hybrid we did not notice any significant influence of POSS additive on mechanical performance of polyethylene.

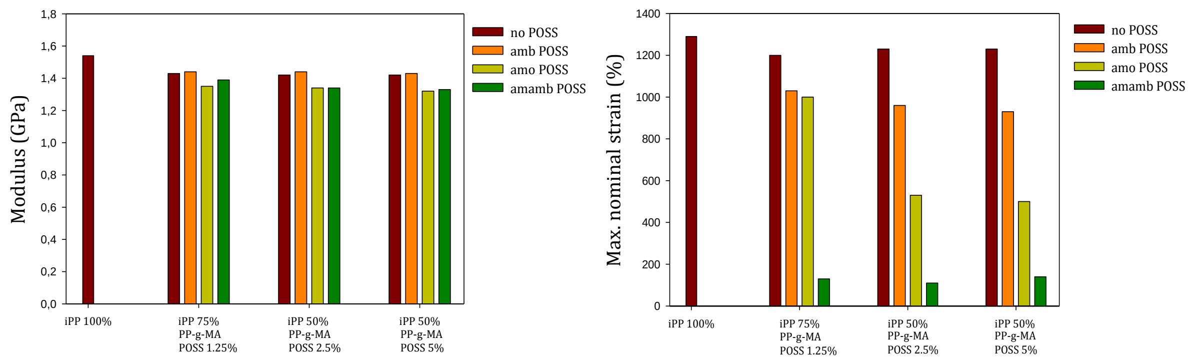

Figure 2. POSS effect on mechanical properties of polypropylene.

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