Synthesis and Properties of Some Novel Polymer Nanocomposites Using Organoclays

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Introduction

Polymer nanocomposites with well dispersed inorganic nanoparticles have attracted great attention because they frequently exhibit unexpected hybrid properties. They typically show significant improvements in physical and mechanical properties that are dramatically different from the conventional microcomposites and their neat counterpart. The most promising type of nanocomposites is polymer-clay nanocomposites in which clays with layered silicate structure are used as the reinforcing part of the matrix. Layered silicates are extremely thin plate-like structures (~1 nm thick and 100-100 nm length), that have large surface areas and high aspect ratios, leading to a high interfacial area between filler and matrix. The platelets have an exceptionally high modulus compared to that of the surrounding polymer matrix. The effect of the inclusion of organoclays on the thermal and mechanical properties of some polymers is going to be presented.

Methods

The hybrid materials were prepared from various types of benzoxazine resin as a novel type of phenolic resin and various organoclays, typically organically modified montmorillonite (OMMT). Another series of hybrids were prepared from vinylester resin (VER) and OMMT. All the hybrids were synthesized by the in-situ polymerization of their precursors either benzoxazine or VER in the presence of OMMT. The hybrids either in mold or film forms were thermally cured to afford the corresponding nanocomposites.

Results and Discussion

DSC and IR were used to study the cure behavior of resin in the presence of organoclay and to monitor the completeness of the cure process. The morphology of the hybrids was studied by XRD, SEM and TEM, indicating the exfoliation and homogenous dispersion of the organoclay into the matrix. The viscoelastic properties of the hybrids showed that the nanocomposites have higher T_g and higher storage modulus over the whole temperature range than the neat resin, suggesting the restriction of the network segmental mobility by the dispersed clay nanolayers. TGA of the hybrids indicated that the thermal stability increased apparently by hybridization with organoclays.

Biographical Sketch

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Dr. Tarek Agag has received his Ph.D. degree in 2001 at Toyohashi University of Technology (TUT), Toyohashi, Japan. His thesis was entitled *"Studies on Performance Improvement of Polybenzoxazines as a Novel Type of Phenolic Resins"*. After completing his Ph.D., he has been appointed as a lecturer at the Department of Chemistry, Tanta University, Tanta, Egypt. In 2001, he has been awarded the very prestigious JSPS postdoctoral Fellowship for the foreign researcher from Japanese Government. He joined to Prof. T. Takeichi's group at TUT from Sept. 2002 to Sept. 2004 as a JSPS Postdoctoral Fellow. He is currently doing some collaproative research projects with Prof. Takeichi.

His research interests are focused on designing benzoxazine resin-based materials with well-adjusted properties that can find a potential use in various industrial applications. Also, he is interested in polymer nanocomposites in which organoclays or metal oxide via sol-gel are used as nanoparticles with various polymer types including polybenzoxazine, polyimide, polyurethane, epoxy resin and vinyl polymers.