PHYSICAL AND BARRIER PROPERTIES OF COPOLYMERS REINFORCED WITH CLAY NANOPLATELETS

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ABSTRACT

The reinforcement of polymeric materials with clay platelets has received considerable attention, both in academia and industry. This is due to the clay platelets' high aspect ratio which facilitates strong interaction between polymer matrix and clay platelets so that the physical properties of the resultant material, e.g. flame retardancy, barrier properties and mechanical strength, are enhanced compared to neat polymers. Hence polymer/clay nanocomposites are increasingly replacing neat polymers and conventional microcomposites in many applications, such as packaging, engineering plastics and flame retardants.

Here we report on poly(acrylonitrile-co-methyl acrylate)/clay nanocomposites containing varying clay contents, prepared via in-situ intercalative emulsion polymerisation. The resultant nanocomposites were characterised in terms of their chemical composition, morphology and physical properties. The incorporation of clay did not have an on the copolymer composition, which remained fairly constant at a ratio of 3:2 (acrylonitrile: methyl acrylate) from the neat copolymer through to the maximum clay content studied, although the average molecular weight decreased with increasing clay content. The morphology of these nanocomposites remained fairly constant throughout the clay content range studied, and all nanocomposites exhibited a partially exfoliated morphology. The glass transition temperature was unaffected by the clay content due to the broader molecular weight distribution in the nanocomposites than the neat copolymers, such that the expected increase of T_g resulting from chain motion restriction was not observed. Up to a 9^oC increase in temperature at 50% weight loss was observed in the nanocomposites, indicating an improvement in thermal stability of the nanocomposites relative to the neat copolymers. The melt flow properties showed that the storage modulus and complex viscosity increased monotonically with increasing clay content. Strong shear thinning behaviour was observed due to the ability of clay to align in the direction of shear. The neat poly(acrylonitrile-co-methyl acrylate) copolymer and its nanocomposites exhibited higher storage modulus than loss modulus (G' > G") throughout the angular frequency, which is typical of solid like behaviour. The diffusion and permeability coefficients of water in poly(acrylonitrile-co-methyl acrylate)/clay nanocomposites decreased with increasing clay due to the tortous path imparted to the material by the partially exfoliated clay platelets, as well as a reduction in fractional free volume. However the solubility coefficient of water increased with increasing clay content due the hydrophilic nature of the partially exfoliated clay platelets in the polymer matrix.