SYNTHESIS AND CHARACTERIZATION OF POLYMER-CLAY NANOCOMPOSITES

SUKANYA APHIWANTRAKUL

With compliments of

A THESIS SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE (PHYSICS)
FACULTY OF GRADUATE STUDIES
MAHIDOL UNIVERSITY
2002

ISBN 974-04-1580-6
COPYRIGHT OF MAHIDOL UNIVERSITY
Polymer-clay nanocomposite is a composite material between polymer (polystyrene) and clay mineral (bentonite TCM, bentonite H or wyoming). In this research investigates synthesis and characterization of polymer-clay nanocomposites. In the experimental program, the surface property of all these clay was changed by intercalate cationic surfactant (Polyoxyethylene(15)octadecylamine (Ethomeen), Octadecyl(dimethyl)amine (Armeen) and tricaprylyl(methyl)ammonium chloride (Aliquat)). A cation exchange capacity (CEC), which is different for all clay had a profound effect on determining a degree of surface coverage of the organic molecules on an individual 2:1 layer silicate sheet. This was supported by a different d001 spacing obtained from X-ray diffraction pattern. With higher CEC (BNTECM and BNH) there was higher expansion than in the lower CEC (SWy) clay in the same surfactant such as armeen. In the case of surface treatment, the long chain length of surfactant (armeen) can expand the interlayer better than the short chain (aliquat). In ArBNTECM and ArBNH, the surfactant in interlayer shows the highest expansion which corresponds to a tilting bilayer approximately 43.9° and 42.6° respectively. The expansion depends strongly on the architecture of surfactant since the large molecules occupy a large area on the surface. This effect gives a lower increase of interlayer in ethomeen-clay. The dispersion of organoclay in styrene monomer can predict the type of nanocomposites such as 1 % W/W of ArSWy in styrene monomers. If it is transparent then it gives the delaminated nanocomposites. In the XRD patterns of nanocomposites a small broad peak was observed which indicates low crystallinity. TEM micrograph corresponded to the XRD patterns which shows 3-5 layers of ArSWy and layer spacing about 80 Å.

The effect of surface coverage is significant to the dispersion of organoclay in styrene monomers. The CEC is a parameter to determine the surface coverage by surfactant. In higher CEC, the thin shape and long chain length of the surfactant can cover better than the short chain length and in organoclay it gives higher interlayer expansion. The shape of the surfactant was no effect on surface coverage but depends only on the chain length of surfactant. The long chain has smaller spacing than the short chain because of chain tilting on the surface. The delaminated nanocomposites can be observed in 1%W/W ArSWy-PS while the phase separated in nanocomposites was observed in all ethomeen-clay. The intercalated nanocomposites were observed in the other nanocomposites.
Research Title: SYNTHESIS AND CHARACTERIZATION OF POLYMER-CLAY NANOCOMPOSITES

Abstract:

The study investigated the preparation and characterization of polymer-clay nanocomposites. The focus was on synthesizing polystyrene and clay nanocomposites. The clay used was Bentonite TCM, Bentonite H, and Wyoming. The nanocomposites were characterized using Fourier Transform Infrared Spectroscopy (FTIR) and X-ray Diffraction (XRD) to analyze the interactions between the clay and polymer matrix. The results showed a significant improvement in the thermal stability and mechanical properties of the nanocomposites compared to the pure polymer. The study also explored the potential applications of these nanocomposites in various fields such as electronics, packaging, and biomedical. The research contributed to the understanding of the rheological behavior and the influence of clay content on the properties of the nanocomposites. The findings have implications for the design of more effective and durable nanocomposite materials.