Abstract

Nanoclays (sodium montmorillonite, potassium montmorillonite and bentonite) have been modified using amines with various carbon chain lengths (decyl amine, dodecyl amine, hexadecyl amine or stearyl amine). Styrene butadiene rubber (SBR), acrylonitrile butadiene rubber (NBR) and polybutadiene rubber (BR) based nanocomposites have been prepared using these nanoclays by solution intercalation method. In order to understand the systems more precisely, SBR and NBR with varying polarity and comonomer contents have also been taken. The nanoclays have been examined by Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), X-Ray Diffractogram (XRD) etc. The results confirm the intercalation and modification of the clays by amines. Similar experiments have been carried out on nanocomposites to confirm intercalation and exfoliation behavior of the nanoclays in the rubber matrix. Atomic Force Microscopy (AFM) and Transmission Electron Microscopy (TEM) of the nanocomposites have also been carried out to show the filler dimension and dispersion in the rubber matrix. The mechanical properties of the SBR based nanocomposites show significant improvement in tensile properties. Increasing loading of the modified filler till 16 phr shows constant improvement in tensile properties.

The processing parameters like the solvents used to cast the SBR nanocomposite sample and the cure time have been varied and the effects on mechanical properties have been noted.

The mechanical properties of the nanocomposites based on NBR, SBR and BR and their various grades have been compared and correlated with their micro- and nano- structures. The properties have been elucidated with the help of TEM and XRD results. The effect of filler loading on the properties of each grade of NBR has also been studied. The barrier properties have also been measured for the representative samples.

The morphology of the nanocomposite have been studied in detail by AFM and TEM. Variation includes nature of the matrix, filler loading and solvent used to cast the samples. These parameters influence their structure significantly.

The rheological behavior of the gum elastomers and their nanocomposites has been investigated. Under capillary rheometer they show unique behavior, where the viscosity decreases with incorporation of the modified filler upto a certain loading. The die swell decreases under the same condition.

The storage modulus of these nanocomposites increases with loading of filler. The intercalated rubber in the filler gallery behaves as bound rubber. The tan delta shows a shift towards higher temperature with the modified clay loading in general.

The nature of thermal degradation remains almost unchanged with nanoclay loading, although the rate of degradation improves. The change in degradation temperature varies from 2° to 10° depending on the matrix. The nature of degradation changes with the change in the heating environment. The activation energy of degradation has also been calculated and is found to be higher for the modified clay filled nanocomposites.

Key Words: Styrene Butadiene Rubber, Acrylonitrile Butadiene Rubber, Polybutadiene Rubber, Nanoclay, Nanocomposites, Montmorillonite, Bentonite, Mechanical Properties, Thermal Properties, Dynamic Mechanical Properties, Rheological Behavior, Morphology, Atomic Force Microscopy.