

Improving the Properties of Industrial Polyurethane with Nanoclay, Hectorite

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Introduction

Polyurethane is unique material exhibiting varying mechanical strength and other properties enabling to be used in many different applications such as automotive, coatings and biomedical [1,2]. In some applications the mechanical strength can not be enough. To overcome the limitations of the use of polyurethane, it is reinforced with fillers [3]. The nanoreinforcements open new dimensions reinforcing the polymer without losing other properties [4].

In this work, we have improved the properties of the polyurethanes using the clays as the nano-scale reinforcing agent [5]. In previous studies, the montmorillonite clay has been examined to reinforce the polyurethane polymer [6, 7]. No work has been reported using the clay hectorite. In this work, we have investigated the effect of the hectorite to improve the properties of the polyurethane.

In some polymers it has been observed that hectorite improves the mechanical properties of the matrix polymer better than the montmorillonite clay [8, 9]. The ion exchange capacity of the hectorite we have used is higher than the montmorillonite used in our labs. The rheological properties have been observed very well which can form nanocomposite easily.

Experimental

Materials. In this study, industrial polyurethane has been used. The polyurethane is polyester polyol based and reacted with the isocyanate MDI (diphenylmethane diisocyanate) and 1,4 butanediol is used as chain extender.

The nanoreinforcement is accomplished with the clay mineral, hectorite, from Turkish natural resources. The hectorite was taken from the mountains of Afyon city of Turkey.

Composite Preparation. The nanocomposites have been prepared with solvent casting method. The polyurethane-dimethylformamide (DMF) solution has been mixed with DMF-clay solution and casted on a special paper and the composite film has been obtained via solvent evaporation.

Characterization. The clays have been characterized with ion-exchange capacity measurement, rheological measurements, zeta-potential measurements and particle size measurement. The composite materials have been characterized and tested with X-ray analysis, tensile testing, dynamic mechanical analysis and electron microscopy techniques.

Results and Discussions

Ion-exchange Capacity. The ion-exchange capacity has been measured as 95 which is higher than montmorillonite from Turkish resources as well (86). This is very important for the performance of the composite.

Rheological Measurement

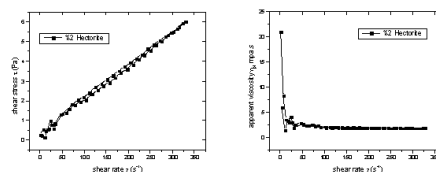


Figure 1. The rheological behavior of the clay

The above figures indicate the thixotropic behavior of the clay mineral.

Particle Size Measurement

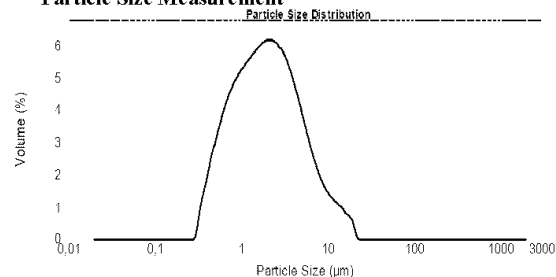


Figure 2. The particle size measurement of the clay material

With this measurement it was observed that the clay had finally 2 micron meter average particle diameter.

X-Ray Analysis. X-Ray analysis has shown that the exfoliated structure could be obtained at even 5 % without any organic modification. This is one of the significant results of the research. This is due to the hydrophilic character of both the polyurethane matrix and the filler clay.

Mechanical Properties: Improvement in the mechanical properties has been observed indicating that the nanocomposite is successfully prepared.

Conclusion:

Polyurethane nanocomposites have been obtained with the clay, hectorite for the first time. Hectorite was chosen as it showed better properties than montmorillonite. The exfoliated structure has been obtained without organic modifier due to the hydrophilic nature of the polyurethane and the clay mineral. The mechanical properties of the pristine polymer, polyurethane have been improved with clay.

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