(ID 058)

Surface Modification of Montmorillonite Clay Towards the Fabrication of Nanocomposites for Engineering Applications

Nayanthara, H.H.D.[1], Karunarathne, P.K.D.M.C.[1]*, Narangoda, C.J.[2]

[1]Department of Chemistry, University of Sri Jayewardenepura, Nugegoda, Sri Lanka
[2]Department of Chemistry, Centre for Advanced Material Research, University of Sri Jayewardenepura, Nugegoda, Sri Lanka
*mck@sjp.ac.lk

Abstract

Montmorillonite (MMT) is a layered clay mineral composed of silica and alumina sheets with a layer thickness of about 1 nm qualifies it as a two-dimensional nanomaterial. MMT is found in natural clay ores in the Murunkan, Kirinda, and Okanda areas in Sri Lanka. Nanocomposites with enhanced physical and mechanical properties can be prepared by dispersing MMT in a polymer matrix. However, the hydrophilic nature of MMT hinders the incorporation of MMT into hydrophobic polymer matrices. Hence, a suitable surface modification is required to make MMT compatible with polymers. The present study was based on the preparation and analysis of organically modified calcium Montmorillonite (Ca-MMT)-polypropylene nanocomposites as a green technology initiative. Homo-ionic Ca-MMT was prepared by treating commercial MMT-K10 with a $CaCl_2$ solution. The predominant exchangeable divalent cations present in MMT-K10 and Ca-MMT were determined using AAS. The cation exchange capacity of Ca-MMT was about two times greater than that of MMT-K10. Furthermore, XRD analysis showed a slight increase in d-spacing of Ca-MMT compared to MMT-K10. A novel ligand, triethylene glycol dodecyl methyl ether was synthesized by treating triethylene glycol monomethyl ether (TGME) with 50% w/w aqueous solution of sodium hydroxide followed by 1-bromododecane with the molar ratio of TGME:NaOH:1-bromododecane in 1:2:2. The crude product was purified by column chromatography and characterized by FTIR and GCMS analysis. Hydrophilic Ca-MMT was surface modified with the organic ligand presumably via the coordination of triethylene glycol moiety with Ca^{2+} cations at the outer edge of the MMT particles. The long aliphatic chains in the periphery of the modified MMT particle make it more organophilic. Modified Ca-MMT was characterized by XRD, TGA, and FTIR analysis. The XRD revealed a slight increase in the d-spacing related to the 001 plane of modified Ca-MMT compared to unmodified clay. The effect of modified Ca-MMT loadings (0.5%, 1%, and 1.5%) on the mechanical properties of the nanocomposite was studied. The results implied an enhancement of the mechanical properties in terms of impact resistance, hardness, and flexural properties in the nanocomposite compared to the virgin polymer. The fabricated nanocomposite is a promising engineering material that may have applications in automotive, construction, and packaging products.

Keywords: Montmorillonite, Polypropylene, Nanocomposite, TGME, Compatibility