

Ternary nanocomposite system composing of graphene nanoplatelet, cellulose nanofiber and jatropha oil based waterborne polyurethane: characterizations, mechanical, thermal properties and conductivity

ABSTRACT

This work aims to evaluate the performance of graphene nanoplatelet (GNP) as conductive filler with the presence of 0.5 wt.% cellulose nanofiber (CNF) on the physical, mechanical, conductivity and thermal properties of jatropha oil based waterborne polyurethane. Polyurethane was made from crude jatropha oil using an epoxidation and ring-opening process. 0.5, 1.0, 1.5, 2.0 wt.% GNP and 0.5 wt.% CNF were incorporated using casting method to enhance film performance. Mechanical properties were studied following standard method as stated in ASTM D638-03 Type V. Thermal stability of the nanocomposite system was studied using thermal gravimetric analysis (TGA). Filler interaction and chemical crosslinking was monitored using Fourier-transform infrared spectroscopy (FTIR) and film morphology were observed with field emission scanning electron microscopy (FESEM). Water uptake analysis, water contact angle and conductivity tests are also carried out. The results showed that when the GNP was incorporated at fixed CNF content, it was found to enhance the nanocomposite film, its mechanical, thermal and water behavior properties as supported by morphology and water uptake. Nanocomposite film with 0.5 wt.% GNP shows the highest improvement in term of tensile strength, Young's modulus, thermal degradation and water behavior. As the GNP loading increases, water uptake of the nanocomposite film was found relatively small (<1%). Contact angle test also indicates that the film is hydrophobic with addition of GNP. The conductivity properties of the nanocomposite film were not enhanced due to electrostatic repulsion force between GNP sheet and hard segment of WBPU. Overall, with addition of GNP, mechanical and thermal properties was greatly enhanced. However, conductivity value was not enhanced as expected due to electrostatic repulsion force. Therefore, ternary nanocomposite system is a suitable candidate for coating application.

Keyword: Nanocellulose; Graphene nanoplatelet; Bio-based polyol; Biopolymer; Bio-based film; Bio-composite