

Comparison between natural rubber, liquid natural rubber, and recycled natural rubber as secondary matrix in epoxy/natural rubber/graphene nano-platelet system

Abstract

A comparison is made between the effects of natural rubber (NR), liquid natural rubber (LNR), and recycled natural rubber (rNR) in the filled epoxy systems on the physical, mechanical, thermal, and electrical performances of filled epoxy systems. The results show that flexural strength and modulus values were improved. The toughness properties of the filled epoxy system were enhanced with NR phases (72 MPa, 2317 MPa, 4.2 MPa. m^{1/2}), as compared to those with LNR (55 MPa, 2100 MPa, 3.2 MPa. m^{1/2}) and rNR (52 MPa, 2000 MPa, 2.3 MPa. m^{1/2}) at 5 vol.%. Scanning electron micrograph (SEM) analysis revealed that the particle sizes of NR phases dispersed within the epoxy matrix were smaller and more uniform (0.29-1.65 μm) as compared to those with LNR (0.64-3.57 μm) and rNR (≥ 250 μm) phases. The incorporation of NR, LNR, and rNR phases improved the thermal stability of the filled system. This is attributed to more heat energy being needed to overcome good interfacial bonding between epoxy matrices and the small NR phases. X-ray diffraction analysis results showed that the filled epoxy/NR/GNP system has higher 2θ values, indicating that d-spacing in GNP nano-fillers has the closer distance. Electrical bulk conductivity values of filled epoxy/NR/GNP systems were the highest, 4.50 x 10⁻³ 1/Ω. cm at 20 vol.%. Small NR phases acted as elastomer spacers, which provided better GNP packing efficiency and realigned the GNP nano-fillers to form more effective conductive pathways for electron transport. © The Author(s), under exclusive license to Springer Nature Switzerland AG 2023 © Springer Nature Switzerland AG 2021. All rights reserved.

Keywords

Epoxy; Liquid natural rubber; Natural rubber; Polymer blends; Recycled natural rubber