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Kinetically Controlled Localization of Carbon Nanotubes in Polylactide/Poly(vinylidene fluoride) Blend Nanocomposites and Their Influence on Electromagnetic Interference Shielding, Electrical Conductivity, and Rheological Properties

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Abstract

This study illustrates the effects of the kinetic parameters [processing time, polyvinylidene fluoride (PVDF) viscosity, carbon nanotube (CNT) aspect ratio, and processing method] on the CNT migration and consequently the viscoelastic properties, electromagnetic interference shielding effectiveness (SE), dielectric properties, and electrical conductivities of the corresponding polylactide (PLA)/PVDF/CNT (70/30/0.25 w/w/w) nanocomposites. In the internal mixer, CNTs are premixed with either PLA or PVDF, whereas in the extruder, CNTs are only predispersed in PVDF because the migration route is from PVDF to PLA. The morphology development and CNT migration exhibit time-dependent mechanisms where the properties of the nanocomposites prepared in the internal mixer are relatively higher than those of nanocomposites prepared via the extruder. The viscosity ratio also plays an important role, and more CNTs are found at the interface and PLA when low-viscosity PVDF is employed. The highest SE (7.86 dB), dielectric permittivity (935.23εp'), and electrical conductivity (1.06 × 10–4 S·cm–1 at 0.1 Hz) values are attained when high aspect ratio (L)-CNTs are predispersed with low-viscosity (L)-PVDF, whereas the lowest properties belong to the blends prepared in the extruder when small aspect ratio (S)-CNTs are predispersed with high-viscosity (H)-PVDF (4.5 dB, 6.00 εp', and 2.16 × 10–14 S·cm–1 at 0.1 Hz).