The effects of unbleached and bleached nanocellulose on the thermal and flammability of plypropylene-reinforced kenaf core hybrid polymer bionanocomposites

ABSTRACT

The thermal, thermo-mechanical and flammability properties of kenaf core hybrid polymer nanocomposites reinforced with unbleached and bleached nanocrystalline cellulose (NCC) were studied. The studied chemical composition found that unbleached NCC (NCC-UB) had 90% more lignin content compared to bleached NCC (NCC-B). Nanocelluloses were incorporated within polypropylene (PP) as the matrix, together with kenaf core as a main reinforcement and maleic anhydride grafted polypropylene (MAPP) as a coupling agent via a melt mixing compounding process. The result showed that the thermal stability of the nanocomposites was generally affected by the presence of lignin in NCC-UB and sulfate group on the surface of NCC-B. The residual lignin in NCC-UB appeared to overcome the poor thermal stability of the composites that was caused by sulfation during the hydrolysis process. The lignin helped to promote the late degradation of the nanocomposites, with the melting temperature occurring at a relatively higher temperature of 219.1 °C for PP/NCC-UB, compared to 185.9 °C for PP/NCC-B. Between the two types of nanocomposites, PP/NCC-B had notably lower thermo-mechanical properties, which can be attributed to the poor bonding and dispersion properties of the NCC-B in the nanocomposites blend. The PP/NCC-UB showed better thermal properties due to the effect of residual lignin, which acted as a compatibilizer between NCC-UB and polymer matrix, thus improved the bonding properties. The residual lignin in PP/NCC-UB helped to promote char formation and slowed down the burning process, thus increasing the flame resistance of the nanocomposites. Overall, the residual lignin on the surface of NCC-UB appeared to aid better stability on the thermal and flammability properties of the nanocomposites.

Keyword: Lignin; Sulfation; Compatibilizer; Thermal stability; Bleaching; Hybrid nanocomposites