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Design of 3D printable boehmite alumina/thermally exfoliated reduced graphene oxide-based polymeric nanocomposites with high dielectric constant, mechanical and thermomechanical performance

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Abstract:
In this study, melt-blending was employed to blend 80 wt% poly(lactic acid) and 20 wt% poly(ε-caprolactone) (80 %PLA/20 %PCL) with boehmite alumina-thermally exfoliated reduced graphene oxide (BA-TERGO) as nanofillers. Herein, we present a novel synergy effect of BA/TERGO particles on improving the dielectric constant while maintaining dielectric loss at lower magnitudes. Also, improving the thermomechanical properties of tough PLA/PCL nanocomposite through the incorporation of a dual-filer system strategy. Consequently, remarkable increase in dielectric constant was achieved for BA-TERGO/blend nanocomposite. In particular, the blend exhibited dielectric constant of about 2.91, while the BA-TERGO/blend nanocomposite exhibited dielectric constant of about 4.93 at a frequency of 2.0 ×10 6 Hz and a temperature of 190 ºC. On the other hand, tensile modulus of the BA-TERGO/blend nanocomposite increased from 1908.5 MPa to 2505.2 MPa and the tensile strength increased from 70.48 MPa to 96.3 MPa when compared to that of the neat blend. BA-blend and BA-TERGO/blend nanocomposites provided the improved storage modulus and thermal stability. This finding renders PLA-based biodegradable materials suitable for tough 3D printable material with potential for integrated circuits applications.