Complex permittivity and power loss characteristics of α-Fe2O3/polycaprolactone (PCL) nanocomposites: effect of recycled α-Fe2O3 nanofiller

ABSTRACT

The development of microwave absorbing materials based on recycled hematite (α-Fe2O3) nanoparticles and polycaprolactone (PCL) was the main focus of this study. α-Fe2O3 was recycled from mill scale and reduced to nanoparticles through high energy ball milling in order to improve its complex permittivity properties. Different compositions (5% wt., 10% wt., 15% wt. and 20% wt.) of the recycled α-Fe2O3 nanoparticles were melt-blended with PCL using a twin screw extruder to fabricate recycled α-Fe2O3/PCL nanocomposites. The samples were characterized for their microstructural properties through X - ray diffraction (XRD) and high resolution transmission electron microscopy (HRTEM). The complex permittivity and microwave absorption properties were respectively measured using the open ended coaxial (OEC) probe and a microstrip in connection with a vector network analyzer in the 1–4 GHz frequency range. An average α-Fe2O3 nanoparticle size of 16.2 nm was obtained with a maximum imaginary (ε") part of permittivity value of 0.54 at 4 GHz. The complex permittivity and power loss values of the nanocomposites increased with recycled α-Fe2O3 nanofiller content. At 2.4 GHz, the power loss (dB) values obtained for all the nanocomposites were between 13.3 dB and 14.4 dB and at 3.4 GHz, a maximum value of 16.37 dB was achieved for the 20 % wt. nanocomposite. The recycled α-Fe2O3/PCL nanocomposites have the potential for use in noise reduction applications in the 1–4 GHz range.

Keyword: Recycled hematite; Complex permittivity; Nanocomposites; Power loss; Finite element method; Nanomaterials; Computational materials science; Materials application; Materials characterization; Nanostructure; Nanotechnology; Materials science