Controlling the properties of OPEFB/PLA polymer composite by using Fe2O3 for microwave applications

ABSTRACT

Microwave-absorptive polymer composite materials provide protection against interference to communication systems caused by microwave-inducing devices. Microwave-absorptive polymer composites were prepared from polylactic acid (PLA) biocomposite blended with oil palm empty fruit bunch (OPEFB) fiber and commercial Iron oxide (Fe2O3) as filler using the melt-blending method. The composites characterization was carried out using the scanning electron microscopy (SEM) and X-ray diffraction (XRD) analyses. The coefficient of reflection S11 and coefficient of transmission S21 of the composites for various Fe2O3 filler percentages were determined using a rectangular waveguide in connection with microwave vector network analyser (HP/Agilent model PNA N5227). These coefficients were then used to calculate microwave-absorption properties (in decibels). XRD analysis showed that increasing amounts of reinforced material (Fe2O3) reduces the crystallinity of the composites. SEM data indicated that Fe2O3 filler ratio increased in the composites, and adhesion to the cellulose fiber grew gradually until the highest percentage of filler was added. The complex relative permittivity and relative permeability were obtained within the broad frequency range of 8ï 12 GHz at room temperature for various percentages of filler and were measured by the transmission/reflection method using a vector network analyser. Fe2O3 embedment in OPEFB/PLA was observed to have resulted in enhancing the dielectric and magnetic properties. The values of permittivity and permeability increased with increasing Fe2O3 filler content. Theoretical simulation studied the relation between $\acute{\varepsilon}_{ij}$ and $\acute{\varepsilon}_{ij}$ of the relative complex permittivity in terms of Cole-Cole dispersion law. The result indicated that the processes of Debye relaxation in Fe2O3/OPEFB/PLA, the unique dielectric characteristics of Fe2O3 cannot be accounted for by both the Debye dipolar relaxation and natural resonance. Results further showed that the material transmission, reflection, and absorption properties could be controlled by changing the percentage of Fe2O3 filler in the composites.

Keyword: Polymer composite; Melt blending; Permittivity; Permeability; Cole-Cole