Computational and experimental approaches for determining scattering parameters of OPEFB/PLA composites to calculate the absorption and attenuation values at microwave frequencies

ABSTRACT

This article describes attenuation and absorption measurements using the microstrip transmission line technique connected with a microwave vector network analyzer (Agilent 8750B). The magnitudes of the reflection (S11) and transmission (S21) coefficients obtained from the microstrip transmission line were used to determine the attenuation and absorption of oil palm empty fruit bunch/polylactic acid (OPEFB/PLA) composites in a frequency range between 0.20 GHz and 12 GHz at room temperature. The main structure of semi-flexible substrates (OPEFF/PLA) was fabricated using different fiber loading content extracted from oil palm empty fruit bunch (OPEFB) trees hosted in polylactic acid (PLA) using the Brabender blending machine, which ensured mixture homogeneity. The commercial software package, Computer Simulation Technology Microwave Studio (CSTMWS), was used to investigate the microstrip line technique performance by simulating and determine the S11 and S21 for microwave substrate materials. Results showed that the materials' transmission, reflection, attenuation, and absorption properties could be controlled by changing the percentage of OPEFB filler in the composites. The highest absorption loss was calculated for the highest percentage of filler (70%) OPEFB at 12 GHz to be 0.763 dB, while the lowest absorption loss was calculated for the lowest percentage of filler 30% OPEFB at 12 GHz to be 0.407 dB. Finally, the simulated and measured results were in excellent agreement, but the environmental conditions slightly altered the results. From the results it is observed that the value of the dielectric constant (ε′r) and loss factor (ε″r) is higher for the OPEFB/PLA composites with a higher content of OPEFB filler. The dielectric constant increased from 2.746 dB to 3.486 dB, while the loss factor increased from 0.090 dB to 0.5941 dB at the highest percentage of 70% OPEFB filler. The dielectric properties obtained from the open-ended coaxial probe were required as input to FEM to calculate the S11 and S21 of the samples.

Keyword: Attenuation; Absorption; Reflection; Transmission; Microstrip; COMSOL