Electromagnetic properties of magnetite/epoxy resin composites at X-band frequency

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ABSTRACT

This paper aims to investigate the electromagnetic properties of magnetite/epoxy resin composites in the range of 8.2-12.4 GHz (X-band) frequency. The crystalline structure of magnetite (Fe_3O_4) powder was confirmed by X-ray Diffraction (XRD). The magnetite powder with different weight percent (4, 8 and 12 wt%) was dispersed into epoxy resin (with ratio 2 : 1 epoxy and hardener) matrix mixture and poured into rectangular waveguide sample holder with dimensions (22.86 width × 10.16 height ×2 thickness) mm. The magnetite/epoxy resin composites were cured under room temperature for 24 hours before grounded and polished. Density kit was used to measure bulk density of the composites and the result showed an increment as the wt% of magnetite increased. Surface morphology of the composites were examined by Field Emission Scanning Electron Microscope (FESEM). The effects of epoxy resin containing different wt% of magnetite on scattering parameters, relative permittivity, ε_r and permeability, μ_r electrical conductivity, σ and absorption coefficient, A were studied. Scattering parameters of reflection, S_{11} and transmission, S_{21}, were measured by vector network analyser (VNA). The complex ε_r and μ_r were calculated by Nicolson-Ross-Weir (NRW) conversion technique using the measured complex S_{11} and S_{21}. The 12 wt% composite had the highest value of real part of permittivity due to greater reflection coefficient and also highest dielectric loss factor. Each of the composite had very low magnetic loss mechanism and the value of μ_r was nearly unity. The σ of the composites increased with frequency where the 8 and 12 wt% contents showed highest value of conductivity. The loss due to sample's absorption, A was calculated using $A = 1 - |S_{11}|^2 - |S_{21}|^2$ and it was found that 12 wt% had higher absorption.

KEYWORDS:

Complex networks; Dielectric losses; Electric network analyzersIron oxides