UNIVERSITI TEKNOLOGI MARA

ELECTRICAL, MAGNETIC AND MICROWAVE ABSORPTION PROPERTIES OF Fe SUBSTITUTED $La_{0.85}Ag_{0.15}Mn_{1-x}Fe_xO_3$ (x=0, 0.05, 0.10, 0.15 and 0.20) MONOVALENT DOPED MANGANITES

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ABSTRACT

$La_{0.85}Ag_{0.15}Mn_{1-x}Fe_xO_3$ (x=0, 0.05, 0.10, 0.15 and 0.20) monovalent-based manganites, were prepared using conventional solid-state method to investigate the effect of Iron (Fe) substitution on the electrical, magnetic and microwave absorption properties. The phase identification were investigated using X-ray diffraction (XRD) pattern, showed all samples are single phase rhombohedral crystal structure. From temperature dependence resistivity curves, it was found that the Fe substitution increased the resistivity in the temperature region of 30 – 310 K and decrease in metal-insulator transition temperature, T_{MI} from 239.93 K to 67.97 K for x=0 – 0.10 while for x=0.15 and 0.20, the samples exhibit insulating behavior for the whole temperature region. The decreased in T_{MI} indicates weakening of double exchange mechanism due to reduction of Mn^{3+}/Mn^{4+} ratio as Mn^{3+} concentration decreased as a result of substitution. From real part of susceptibiltiy,χ' vs temperature curves, ferromagnetic-paramagnetic transition temperature, Tc was found to be decreased from 299.06 K (x=0) to 141.85 K (x=0.20) indicates Fe substitution weakened ferromagnetic interactions between Mn ions. Fe substitution is suggested to increase the scattering effects in metallic region as electron-electron and electron-magnon scattering parameters increased with Fe concentration of x=0, 0.05 and 0.10. While in the insulating region, the substitution enhances electron-phonon coupling as activation energy, E_a and hopping energy, E_h increased with Fe concentration from 101.55 meV (x=0) to 161.07 meV (x=0.20) and 40.97 meV (x=0) to 139.38 meV (x=0.20), respectively. Microwave absorption performance which implies by value of reflection loss, RL measurements in the frequency range of 8 GHz to 18 GHz showed the highest reflection loss for x = 0 sample where value of reflection loss of –57.2 dB at 16.41 GHz with a bandwidth of 2.67 GHz corresponding to reflection loss below –10 dB was observed. However, with the increasing of Fe concentration, the RL values decreases from –29.5 dB (x=0.05), –9.8 dB (x=0.10), and –6.8 dB (x=0.15) and increase to –13.8 dB (x=0.20) at frequency 16.35 GHz, 14.79 GHz, 14.40 GHz and 16.26 GHz, respectively. It is also found that frequency of the RL peaks match the location of impedance matching, Z_{in}/Z_o minimum for each sample which in turn is influenced by the changes in sample's resistivity due to Fe doping. The observed nearly constant of eddy current coefficient, C_o value in C_o vs frequency curves indicates that eddy current loss is important contributor factor for the magnetic loss mechanism for most samples in the range of matching frequency. On the other hand, measurements of imaginary part of permittivity, ε'' accompanied by enhanced tan δ_e with Fe content indicates Fe doping enhancing the dielectric loss component and contributes to microwave absorption in the samples. It is suggested that good microwave absorption performance for x=0 sample dominantly influence by its weak ferromagnetic properties. While for Fe-substituted samples, it is suggested that the large number of localized charge carrier contribute to enhancement of dielectric loss mechanisms consists of conduction loss. The observed strong absorption, coupled with wide band performance suggests the possibility of using these manganites as a new material in the design of microwave absorbers.

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