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Effect of Ce ion Doping on the Microwave Shielding Properties of Ni-Zn Ferrite/Polythiophene Nano-Composites

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ABSTRACT

Successful synthesis of polycrystalline Ni-Zn ferrite doped by Ce was achieved using sol gel auto-combustion method. Single phase spinel cubic structure has been obtained for all the samples, except for the sample with x = 0.08. It denotes that doping an appropriate amount of Ce^{3+} ions into ferrite can replace the Fe^{3+} ions on the octahedral sites. The increase of Ce content led to the increase of average grain size up to x = 0.04. The average grain size for the sample with x = 0.08 was found to decrease. This has been attributed to the formation of Ce_2O_3 phase along the grain boundaries that inhibit the grain growth. Synthesis of PTH/Ni-Zn ferrite composites has been achieved by surfactant assisted in situ emulsion polymerization of thiophene monomer for the investigation of microwave shielding in X-band frequency range. The higher values of ε' and ε" have been obtained on composite formation and can be due to the heterogeneity developed in the material. An enhancement in the value of saturation magnetization (123 emu/g for x = 0.04) and Curie temperature was obtained with Ce concentration, which is useful for high density recording purposes. A low value of saturation magnetization has been obtained for PTH/Ni-Zn ferrite composite. The overall shielding effectiveness ($SE_T = SE_A + SE_R$) up to 34 dB (~99.9 % attenuation) has been recorded for PTH/$Ni_{0.5}Zn_{0.5}Fe_{2-x}Ce_xO_4$ composites (x = 0.04) in the frequency range of 8.2-12.4 GHz (X-band). Hence, surpasses the shielding criteria of SE_T > 30 dB for commercial purposes. Such a material with high SE identifies their potential for making future electromagnetic shields.

Keywords: Composites, Ferrites, Magnetic properties, Microwave shielding, Polythiophene (PTH).