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Effects of heat treatment on the structural, spectral, morphological, dielectric, and magnetic properties of $Ba_{0.5}Sr_{0.1}Zn_{0.4}Fe_{12}O_{19}$ ferrite

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ABSTRACT

M-type Hexa-ferrites powders of chemical composition $Ba_{0.5}Sr_{0.1}Zn_{0.4}Fe_{12}O_{19}$ was prepared by the use of the co-precipitation technique. The heat treatment of this ferrite composition was done at various temperatures (700, 800, 900, 1000, 1100, and 1200 °C) for 6 h. The X-ray diffraction (XRD) analysis of all the prepared powder samples confirmed the emergence of a hexagonal structure. The high-intensity peaks of the samples were indexed and showed a single phase. The size of crystallite was obtained within the range of 21–42 nm. The surface morphology was carried out with a Scanning electron microscope (SEM). The grain size showed the hexagonal shape, and average grain sizes were in the range of ~ 211 nm. Spectral information was found using the Fourier transform infrared (FTIR) spectroscopy to confirm the phase of M-type hexaferrite. The dielectric parameters were measured within the high-frequency range of 5 MHz - 3 GHz. The dielectric constant was increased with an increase in temperature. The dielectric studies were found by the establishment of space charge polarization as per the two-layer model provided by Maxwell-Wagner and the study of phenomena of Koop's theory. The magnetic characteristics including coercivity (HcB) and retentivity (Br) were measured from BH/JH hysteresis loops. The enhancement of coercivity was observed from $1.23 \times 10^{+3}$ Oe to $1.50 \times 10^{+3}$ Oe, while the retentivity increased from $1.334 \times 10^{+3}$ G to $1.598 \times 10^{+3}$ G with an increase in temperature. Outstanding properties of synthesized materials suggested their use in large-frequency applications, including recording media and permanent magnets.

1. Introduction

M-type hexaferrite has received the interest of scientists due to its various technological applications, including microwave devices, large-density recording media, large frequency, and also used as permanent magnets. These nanomaterials can be employed easily in numerous electrical and electronic tools in fluffy form due to their greater magnetic characteristics. The nanomaterials are applied in microwave instruments, small motors, and retrospectively magnetic tape uses [1–5]. The generalized formula of M-type is $AB_{12}O_{19}$. Multiple studies were done to improve the magnetic properties of hexaferrite through the cationic replacement of divalent and multivalent ions. As far as ferric (Fe^{3+}) ions in M-type are concerned, the Fe^{3+} ions in the M-type structure of hexaferrite are divided into five unique crystallographic sites; namely one tetrahedral ($4f_1$), one trigonal bipyramidal (2b) site, and three octahedral (2a, 12k, and 4f2). The magnetic order of Ba hexaferrite is in the following manner, such as the 12k, 2a, and 2b sites, which are reconciled to each other concerning crystallographic c-axis

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