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Thermal and infrared spectral analysis of TiCo doped NiZn Y-type strontium hexaferrite synthesized by sol gel autocombustion

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Abstract

TiCo substituted <u>polycrystalline</u> NiZn Y-type <u>strontium</u> nano hexa-ferrites, Sr₂NiZnFe_{12-X}(TiCo)_{X/2}O₂₂ (x=0, 0.5, 1.0, 1.5, 2.0 & 2.5) is synthesized by sol-gel auto combustion route via <u>microwave irradiation</u>. The thermal behaviour of the prepared sample was investigated by <u>TGA</u> and <u>DTC</u>. The <u>exothermic peak</u> on <u>TGA</u> reveals the temperature of Sr2NiZn -Y ferrite phase formation at 905 °C. <u>Seebeck Coefficient</u> is obtained from <u>DTC</u>. Infrared spectrum of this solid phase <u>inorganic materials</u> in the mid infra-red region 4000–400 cm⁻¹ are taken to study fundamental <u>molecular vibration</u>. The fundamental molecular <u>vibration</u> frequencies are absolutely related with respective force constants of atomic group environment. The presence of higher <u>vibrational frequency</u> at 590 cm⁻¹ (589–596 cm⁻¹) (v1) as calculated for tetrahedral and <u>lower vibration frequency</u> at 430 cm⁻¹ (427–437 cm⁻¹) (v2) as calculated for octahedral confirm that the higher force field present in tetrahedral surrounding atom than octahedral.

Introduction

Modern telecommunications system would not be possible without ferrites. Ferrites are various compositions of ferrous oxides Fe²⁺O and ferric oxide Fe³⁺₂O₃ having larger electric resistivity than the ferromagnetic materials. Soft ferrites have higher electric resistivity, i.e., these are dielectrics. The soft ferrites are useful in the high-frequency applications e.g. isolator, phase shifter, circulator, and high-speed switch. The ferrites development has continuously providing novel technological applications either in the electronic and magnetic technology and in biotechnology also. Their electronic applications cover a wide range covering millimetre wave integrated circuitry to power transmission and magnetic applications from simple permanent magnets to advanced high-density magnetic recording [1]. Ferrites consist of Spinel, Garnet and Hexaferrite. Six major hexaferrites are; W-type (BaMe2Fe16O27), M-type (BaFe12O19), X-type (Ba2Me2Fe28O46), Y-type (Ba2Me2Fe12O22), U-type (Ba2Me2Fe28O46), and Z-type Ba3Me2Fe36O60), where Me stand for divalent or trivalent metallic ions [2]. Ferrites higher permeability with high resistivity makes the exact combination in the prevention of eddy currents and for use in high frequency transformers and adjustable inductors. The performance of a ferrite depends on the circuit impedance with source and load; how much attenuation is required; relevant frequencies for the complex permeability, heeding effects of temperature and field strength [3]. Ferrites in the micrometre scale were first prepared by ceramic method. Ferrites in the nanometre scale is obtained by different methods, such as coprecipitation, hydrothermal, sol-gel, son-chemical, mechanical alloying, citrate precursor, shock wave, reverse micelle, forced hydrolysis in a polyol [4] and also by taking egg white aqueous medium [5].

Section snippets

Experimental details

Synthesis: TiCo substituted polycrystalline NiZn Y-type strontium nano hexa-ferrites, $Sr_2NiZnFe_{12-X}(TiCo)_{X/2}O_{22}$ (x=0, 0.5, 1.0, 1.5, 2.0 & 2.5) is synthesized by sol–gel auto combustion route via microwave irradiation. AR grade cobalt nitrate (Emsure-Merck KGaA, 99.99%), strontium nitrate (Aldrich, 99.99%), zinc nitrate (Emsure-Merck KGaA, 99.99%), nickel nitrate (Emsure-Merck KGaA, 99.99%), iron nitrate (Emsure-Merck KGaA, 99.99%), titanium tetra-chloride (Emsure-Merck KGaA, 99.99%) used as ...

Thermal analysis

Thermo-gravimetric Study: The TGA curve (Fig. 1) shows that the small weight changes in four regions as 30°C–500°C, 500°C–730°C, 730°C–905°C, 905°C–1050°C are 0.996%

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loss, 0.853% loss, 0.148% gain and 0.319% loss of its original weight respectively. The very small loss in weight is observed by removal of absorbed moisture and the exothermic peak at 905 °C belongs to the crystallization of Sr2NiZn-Y ferrite phase formation [6]. Therefore, it can be concluded that the formation...

Conclusions

TiCo substituted polycrystalline NiZn Y-type strontium nano hexa-ferrites, $Sr_2NiZnFe_{12-X}(TiCo)_{X/2}O_{22}$ (x = 0, 0.5, ..., 2.5) is successfully synthesized by sol–gel auto combustion route via microwave irradiation. By decomposing i.e. unmixing inverse Fourier transform, the frequencies of individual signals can calculate. The vibrational frequency calculated by computational multi-order derivative approach is comparable with the experimental observed values in FTIR. The presence of higher...

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper....

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