ScienceDirect

Materials Today: Proceedings

Volume 29, Part 4, 2020, Pages 1033-1038

Morphological study and optoelectrical properties of Zn^{2+} substituted nickel ferrite nanoparticles

P.S. Hedaoo [a], D.S. Badwaik [a], K.G. Rewatkar [b]

Show more

https://doi.org/10.1016/j.matpr.2020.04.706

Get rights and content

Abstract

In this study a series of spinel ferrites having formula $Ni_{(1-X)}Zn_XFe_2O_4$ and substituted with Zn (where X = 0–1, ΔX = 0.2) were prepared by sol gel auto-combustion route using microwave. The crystallite size and its morphology have been analysed by TEM. The average particle size obtained from TEM is about 24–26 nm. EDX study is applied to confirm the elemental compositional proportion of prepared ferrite powder. FTIR analysis revealed the presence of characteristic absorption bands corresponding tetrahedral and octahedral sites confirmed the ferrite samples are formed. The temperature and frequency dependent dielectric properties were studied with impedance analyser. The Maxwell Wagner grain and grain boundary layer model of poly-crystalline ferrite can explain the enhancement of AC conductivity with frequency.

Introduction

Nano-crystalline ferrites have been investigated exhaustively due to their distinct c, optical and electric properties, which are dissimilar from their bulk

equivalents [1]. Amidst nano-crystalline ferrites, Ni-Zn nano spinel ferrites have desperately attracted the researcher community because of their potential usage like high density data storage, EMI suppressors, high-frequency magnetic cores, and ferrofluids. The large electrical resistivity of Ni–Zn ferrites with applicable magnetic properties, are an optional to the Mn–Zn ferrite over last many years within the area of high frequency magnetic cores and might be operated well over one MHz to many 100 MHz with insignificant core losses [2], [3]. By proper controlling the chemical combination and micro-structure of Ni–Zn ferrite, which relies on synthesis route, calcination climate and calcination temperature, the operation frequency of Ni–Zn ferrite core can be adjusted still higher than the several 100 MHz to GHz frequency range by enhancing the electrical resistivity without changing the applicable magnetic parameters of core considerably [1]. Homogenous and uniform microstructures composed of fine grains (conducting grains) which are surrounded by innumerable grain boundaries (highly resistive layer), work as a barrier for electron flow, and thus commanding the eddy current losses, which useful in upgrading the electrical resistivity [4], [5]. Because of this fact, most of the applied field is focused through the grain-boundary area, and thus, electrical behaviour of ferrites is commanded by grain boundaries.

Section snippets

Experimental method

Nano ferrites with formula $Ni_{(1-x)}Zn_xFe_2O_4$ (where X = 0–1, ΔX = 0.2) were prepared by sol gel auto-combustion route using microwave. The precursors $Ni(NO_3)_2$hexahydrate, $Zn(NO_3)_2$hexahydrate, $Fe(NO_3)_3$nonahydrate and urea were taken in stoichiometric ratio and dissolved 30 ml of deionised water. This mixture was stirred to form uniform solution, and then heated up to 80–90 °C under constant stirring. Initially, the water was slowly vanished and then solution gets transferred into gel. The formed…

Surface morphology

TEM images of nickel zinc nano-ferrite are depicted in Fig. 1. TEM images display that the particles are spherical in shape and agglomerated. This is due to the magnetic interaction between nano-particles [6], [7]. The average particle size of sample is 24–26 nm and is closely matched with our earlier published XRD results [8].…

Selected area electron diffraction

Indexed TEM SAED patterns are shown in Fig. 2 indicates the well crystalline nature of prepared nanosize ferrite samples $Ni_{(1-x)}Zn_xFe_2O_4$. The comparison of indexed TEM…

Conclusions

A series of nano ferrites with chemical formula $Ni_{(1-X)}Zn_XFe_2O_4$ were prepared successfully by sol gel auto-combustion route. The average particle size of samples obtained from TEM is about 24–26 nm. Energy dispersive x-ray study confirmed the synthesized nickel zinc nano-ferrites are pure. Presence of two strong absorption bands around wave number 550–600 cm^{-1} and 400–450 cm^{-1} in FTIR spectra confirmed formation of ferrite samples. The increase of conductivity with temperature can be explained…

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.…

Special issue articles Recommended articles

References (22)

T.J. Shinde *et al.*
Mater. Chem. Phys. (2008)

Jingying Wang *et al.*
Solvothermal synthesis and magnetic properties of size-controlled nickel ferrite nanoparticles
J. Alloy. Compd. (2009)

M.H. Mahmoud *et al.*
Synthesis of highly ordered 30nm NiFe2O4 particles by the microwave-combustion method
J. Magn. Magn. Mater. (2014)

P.S. Hedaoo *et al.*
Structural and magnetic studies of Zn doped nickel nanoferrites synthesize by sol-gel auto combustion method
. (2019)

S.C. Watawe *et al.*
Thin Solid Tangsali Films (2006)

A.M. El-Sayed
Electrical conductivity of nickel-zinc and Cr substituted nickel–zinc ferrites
J. Mater. Chem. Phys. (2003)

S. Mahalakshmi *et al.*
ac electrical conductivity and dielectric behavior of nanophase nickel ferrites
J. Alloy. Compd. (2008)

D. Ravinder *et al.*
High-Frequency dielectric behaviour of Li-Mg ferrites
Mater. Lett. (2003)

M. Siva Ram Prasad *et al.*
DC electrical resistivity and dielectric properties of Ni-Zn nanoferrite synthesized via autocombution route
Indian J. Phys. (2015)

S. Nasir *et al.*
J. Sol Gel Sci. Technol. (2011)

View more references

Cited by (7)

Exploring the effect of zinc substitution in nanocrystalline nickel ferrite for enhanced supercapacitor and gas sensing applications
2024, Ceramics International

Show abstract

Effect of hydrothermal processing duration on physical and antimicrobial properties of Mg<inf>0.2</inf>Zn<inf>0.5</inf>Mn<inf>0.3</inf>Fe<inf>2</inf>O<inf>4</inf> ferrite nanoparticles
2023, Materials Science and Engineering: B

Show abstract

Typesetting math: 100%

Structural, surface, magnetic, and dielectric properties of Ni<inf>0.3</inf>Cu<inf>0.3</inf>Zn<inf>0.4</inf>Fe<inf>1.4</inf>Cr<inf>0.6</inf>O<inf>4</inf> spinel ferrite nanocrystals prepared by sol-gel auto combustion route

2023, Inorganic Chemistry Communications

Show abstract

Influence of Cu²⁺ substitution on structural and optical properties of Mg-Zn ferrite nanoparticles

2021, Materials Today: Proceedings

> *Citation Excerpt :*
>
> …From Fig. 7, the FT-IR spectra are found to exhibit two prominent absorption bands ν1 (from 568 to 589 cm−1) and ν2 (from 448 to 461 cm−1). The higher frequency band (ν1) attributed to stretching vibrations of metal ions at tetrahedral (A) sites and the lower frequency band (ν2) assigned to stretching vibrations of metal ions at octahedral (B) sites [35,36]. The values of ν1 and ν2 vibrational frequencies for all samples are listed in Table 4.…

Show abstract

Temperature- and frequency-dependent electrical characterization with humidity properties in MZC nanoferrites ↗

2022, Journal of Materials Science: Materials in Electronics

Effect of nickel substitution on structural and dielectric properties of Mg-Zn based spinel ferrite nanoparticles ↗

2022, Physica Scripta

View all citing articles on Scopus ↗

View full text