UNIVERSITI PUTRA MALAYSIA

PHYSICAL INTERPRETATION OF MAGNETIC BEHAVIOR IN NICKEL ZINC FERRITE BASED ON DIELECTRIC STUDY.

WAN NORAILIANA BT WAN AB RAHMAN

FP 2012 19

PHYSICAL INTERPRETATION OF MAGNETIC BEHAVIOR IN NICKEL ZINC FERRITE BASED ON DIELECTRIC STUDY.

By

WAN NORAILIANA BT WAN AB RAHMAN

Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

January 2012

Abstract of the thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

PHYSICAL INTERPRETATION OF MAGNETIC BEHAVIOR IN NICKEL ZINC FERRITE BASED ON DIELECTRIC STUDY.

By

WAN NORAILIANA BT WAN AB RAHMAN

January 2012

Chair: Associate Professor Mansor Hashim, PhD

Faculty: Science

Nickel Zinc Ferrite is a soft magnetic material and the properties of ferrite are dependent on several factors including the sintering temperature, method of preparation and microstructure. In this research, $Ni_xZn_{1-x}Fe_2O_4$ with x=0.5 and 0.3 were preapared via the conventional ceramic precessing method. The microstructure, magnetic and dielectric properties were studied to understand the physical, magnetic and dielectric properties of the resulting materials. The X-Ray diffraction results confirm the formation of crystalline samples after sintering at 1260°C, 1300°C and 1340°C for both compositions. The microstructure studies of $Ni_{0.5}Zn_{0.5}Fe_2O_4$ and $Ni_{0.3}Zn_{0.7}Fe_2O_4$ showed that the grain size increased and the porosity decreased with increasing sintering temperature. The density of the sample also increased with sintering temperature for both compositions. Physical characteristic of samples were studied using X-Ray Diffraction, SEM and TEM. The permeability components μ', μ'' and dielectric components ε', ε'' were measured using Impedance Analyzer.

The permeability and permittivity for both compostions were observed to increase with increasing sintering temperature due to the contribution of the increasing grain size. Also they decreased with increasing frequency for both compositions. It was also observed that the sample with composition $Ni_{0.3}Zn_{0.7}Fe_2O_4$ has higher permeability and permittivity than $Ni_{0.5}Zn_{0.5}Fe_2O_4$.

From the permittivity and permeability data, dielectric complex-plane plot and magnetic complex-plane plot were obtained.The plots revealed the mechanism of polarization. The dielectric polarization was contributed by the interfacial and dipolar polarizations. Meanwhile the magnetization process were probably dominated by magnetic domain wall movement and magnetic spin rotation. Each polarization and magnetization process was dominant in a particular frequency range.

The variation of the real part of permeability with temperature was measured for both composition at a constant frequency, 10 kHz. For samples with composition, $Ni_{0.5}Zn_{0.5}Fe_2O_4$ the temperature range is from room temperature to 250°C and for samples with composition $Ni_{0.3}Zn_{0.7}Fe_2O_4$ the temperature range is from room temperature to 100°C. The Curie temperature where the ordered state magnetic moment almost totally disappears was observed for $Ni_{0.5}Zn_{0.5}Fe_2O_4$ to be 250°C and for $Ni_{0.5}Zn_{0.5}Fe_2O_4$ to be 100°C.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Muda

TAFSIRAN FIZIKAL SIFAT MAGNET DALAM FERIT NIKEL ZINK BERDASARKAN KAJIAN DIELEKTRIK.

Oleh

WAN NORAILIANA BT WAN AB RAHMAN

Januari 2012

Pengerusi : Prof.Madya. Mansor Hashim, PhD

Fakulti : Sains

Ferit nikel-zink adalah sejenis bahan magnet lembut dan sifat ferit bergantung pada beberapa faktor termasuk suhu pemanasan, cara penyediaan dan mikrostruktur. Dalam penyelidikan ini, $Ni_xZn_{1-x}Fe_2O_4$ dengan x=0.5 and 0.3 disediakan melalui teknik pemprosesan seramik. Sifat mikrostruktur, kemagnetan dan dielektrik dikaji untuk memahami sifat fizik, kemagnetan dan sifat dielektrik bagi bahan tersebut. Keputusan belauan Sinar-X memastikan penghabluran sampel selepas pemanasan pada suhu 1260°C, 1300°C dan 1340°C bagi kedua-dua komposisi. Mikrostruktur bagi $Ni_{0.5}Zn_{0.5}Fe_2O_4$ dan $Ni_{0.3}Zn_{0.7}Fe_2O_4$ menunjukkan bahawa saiz butir bertambah dan keadaan berliang berkurang dengan suhu pemanasan. Kepadatan sampel juga meningkat dengan suhu pemanasan untuk kedua-dua komposisi. Sifat fizikal bahan dikaji menggunakan pembelauan Sinar-X, SEM dan TEM. Komponen ketelapan μ', μ'' dan komponen dielektrik ε', ε'' diukur menggunakan penganalisis impedans.

Ketelapan dan ketelusan bagi kedua-dua komposisi didapati meningkat dengan peningkatan suhu pemanasan berpunca daripada sumbangan saiz butir yang meningkat. Mereka juga menurun dengan peningkatan frekuensi untuk kedua-dua komposisi. Sampel dengan komposisi $Ni_{0.3}Zn_{0.7}Fe_2O_4$ didapati mempunyai ketelapan dan ketelusan yang tinggi daripada $Ni_{0.5}Zn_{0.5}Fe_2O_4$.

Dari data ketelusan dan ketelapan, dielektrik satah kompleks plot dan kemagnetan satah kompleks plot didapati. Plot itu mendedahkan mekanisme pengutuban. Pengutuban dielektrik disumbangkan oleh pengutuban antara muka dan dwikutub. Sementara itu, proses pemagnetan barangkali didominasi oleh pergerakan magnet dinding domain dan magnet putaran spin. Setiap masalah pengutuban dan pemagnetan didominasi pada julat frekuensi tertentu.

Variasi bahagian nyata ketelapan dengan suhu diukur untuk kedua-dua komposisi pada satu frekuensi tetap, 10 kHz. Untuk sampel dengan komposisi $Ni_{0.5}Zn_{0.5}Fe_2O_4$ julat suhu ialah dari suhu bilik hingga 250°C dan untuk sampel dengan komposisi $Ni_{0.3}Zn_{0.7}Fe_2O_4$ julat suhu ialah dari suhu bilik hingga 100°C. Suhu Curie di mana susunan magnet momen hampir hilang didapati untuk $Ni_{0.5}Zn_{0.5}Fe_2O_4$ ialah 250°C dan $Ni_{0.3}Zn_{0.7}Fe_2O_4$ ialah 100°C.

ACKNOWLEDGEMENTS

First and foremost, I would like to extend my deepest praise to ALLAH s.w.t who has given me the patience, strength, determination and courage to complete this project.

It is my pleasure to acknowledge my supervisor, Assoc. Prof. Dr. Mansor Hashim for giving me the oppurtunity and platform to pursue my studies of ferrite science. I would also like to extend my sincere appreciation to all my co-supervisors, Assoc. Prof. Dr. Wan Mohamad Daud Wan Yusoff and Assoc. Prof. Dr. Jumiah Hassan for knowledge on dielectric analysis in this project.

My particular thanks are also owed to my parents, my siblings and family members for their understanding and encouragement. I would also to thank my Magnetic and Nanosize Evolution group (MNEG), En. Ismayadi Ismail, En. Shamsul Ezzad, Idza Riati Ibrahim, Rodziah Nazlan, Norhapishah Abdullah, Ghazaleh, Mehran, Fadzidah Idris, Masni Manap and last but not least Dr. Samaila Bawa Waje and Tania Jahanbin. Furthemore, I would like to thank to all my friends Nurul Ain Shaaidi, Fauzana, Bibi Sabrina, Khairunnisa, Norni, Saufiah, Amalina Hafiza, Ain Rusly, Fadila and others for their endless support and encouragement for me.

Finally, I would like to thank Pn. Norhaslinda, Pn.Norliza, Pn. kamariah, En Kadri Masaud and fellow staff from Faculty of Science and Institute of Advanced Technology for their helping me in every way throughout the course of this work.

I certify that an Examination Committee has met on date of **20 January 2012** to conduct the final examination of Wan Norailiana bt Wan Ab Rahman on her tesis entitled "**PHYSICAL INTERPRETATION OF MAGNETIC BEHAVIOR IN NICKEL ZINC FERRITE BASED ON DIELECTRIC STUDY**" in accordance with Universities and University Colleges Act 1971 and the Constitution of the Universiti Pertanian Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

BUJANG BIN KIM HUAT, PhD

Professor and Deputy Dean

School of Graduate Studies

Universiti Putra Malaysia

Date:

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of **Master of Science**. The members of the Supervisor Committee were as follows:

Mansor Hashim, PhD
Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Chairman)

Wan Mohamad Daud Wan Yusoff, PhD
Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Member)

Jumiah Hassan, PhD
Associate Professor
Faculty of Science
Universiti Putra Malaysia
(Member)

_____
BUJANG BIN KIM HUAT, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia
Date:

DECLARATION

I declare that this thesis is on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.

_____

WAN NORAILIANA BT WAN AB RAHMAN

Date: 20 January 2012

TABLE OF CONTENTS