



UNIVERSITI PUTRA MALAYSIA

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

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

By

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**Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia,
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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.

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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, $\text{Ni}_x\text{Zn}_{1-x}\text{Fe}_2\text{O}_4$ with $x=0.5$ and 0.3 were prepared 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 $\text{Ni}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$ and $\text{Ni}_{0.3}\text{Zn}_{0.7}\text{Fe}_2\text{O}_4$ 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 compositions 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 $\text{Ni}_{0.3}\text{Zn}_{0.7}\text{Fe}_2\text{O}_4$ has higher permeability and permittivity than $\text{Ni}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$.

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, $\text{Ni}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$ the temperature range is from room temperature to 250°C and for samples with composition $\text{Ni}_{0.3}\text{Zn}_{0.7}\text{Fe}_2\text{O}_4$ 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 $\text{Ni}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$ to be 250°C and for $\text{Ni}_{0.3}\text{Zn}_{0.7}\text{Fe}_2\text{O}_4$ 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

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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 pemrosesan 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 $1260^{\circ}C$, $1300^{\circ}C$ dan $1340^{\circ}C$ 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 $\text{Ni}_{0.3}\text{Zn}_{0.7}\text{Fe}_2\text{O}_4$ didapati mempunyai ketelapan dan ketelusan yang tinggi daripada $\text{Ni}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$.

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 $\text{Ni}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$ julat suhu ialah dari suhu bilik hingga 250°C dan untuk sampel dengan komposisi $\text{Ni}_{0.3}\text{Zn}_{0.7}\text{Fe}_2\text{O}_4$ julat suhu ialah dari suhu bilik hingga 100°C . Suhu Curie di mana susunan magnet momen hampir hilang didapati untuk $\text{Ni}_{0.5}\text{Zn}_{0.5}\text{Fe}_2\text{O}_4$ ialah 250°C dan $\text{Ni}_{0.3}\text{Zn}_{0.7}\text{Fe}_2\text{O}_4$ ialah 100°C .

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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.

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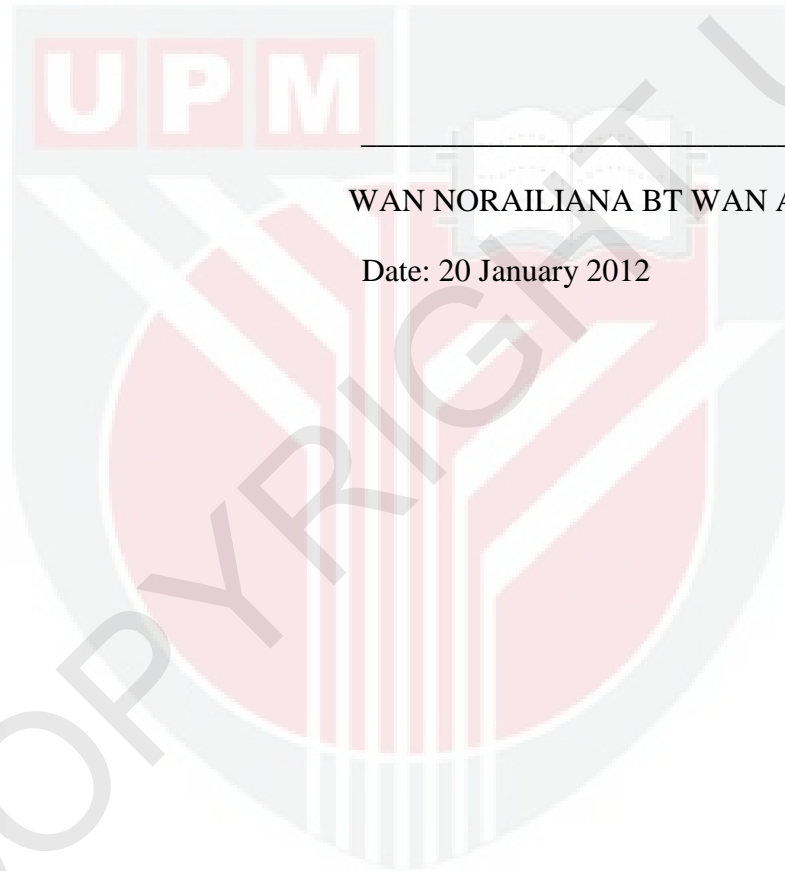
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DECLARATION

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.



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Date: 20 January 2012



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