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Improving the properties of magnetic nano particles (Co_Ni) ferrite by pulsed laser deposition and study its biological effect.

A Thesis

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ
(قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا
إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ
الْعَلِيمُ الْحَكِيمُ) (٣٢)

صدق الله العظيم

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Dedication

*First of all I thank his Almighty Allah, whose
Grace enabled me to continue this work and overcome all
difficulties*

And

To.....

My Parents father and mother

To.....

My brother

To.....

My Friends

To.....

The people who love and supported me all the time

Acknowledgement

First and foremost, I would like to thank Almighty Allah for giving me the strength, knowledge, ability and opportunity to undertake, persevere and complete this research. Without his blessings, this achievement would not have been possible.

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My thanks and appreciation are to due those who helped me with the words or the work of my professors and brothers students, at the University of Diyala .

researcher

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List of symbols

Symbols	Description	Units
d_{hkl}	Inter-atomic distances	nm
hkl	Miller indices	nm
D	Crystalline size	nm
h	Planck constant	J/s
Θ	Diffraction angle	Degree
λ	Wavelength	nm

List of Abbreviations

Abbreviations	Definition
NPs	Nanoparticles
XRD	X-ray diffraction
FWHM	Full width at half maximum
TEM	Transmission electron microscopy
FT-IR	Fourier transform infrared spectroscopy
SEM	Scanning electron microscopy
FE-SEM	Field emission-scanning electron microscopes

VSM	Vibrating sample magnetometer
MRI	Magnetic resonance imaging
FWHM	Full width at half-maximum
PXRD	Powder X-ray diffraction
GMR	Giant magneto resistance
PLD	Pulse Laser Deposition
MHA	Mueller Hinton Agar
RFA	Radio frequency ablation
MNPs	Micronized nanoparticles
MR	Magmatic Recording
MMONPs	magnetic metal oxide nanoparticles

ABSTRACT:

In this research, we prepared magnetic nano particles in format $\text{Co}_{1-x}\text{Ni}_x\text{Fe}_2\text{O}_4$ in two methods. The first method is Co-precipitation and were used pulsed laser deposition (PLD).

We used a mixture of nickel nitrate, cobalt nitrate, iron nitrate, as well as sodium hydroxide as a chelating agent to balance the ratio of the oxidizing agent.

The ferrite NPs were calcined at temperatures (300 °C) for 3 hr. to remove water content and unwanted impurities and to obtain a better single-phase spinel structure. The resulting powder is then compressed into a disc with a diameter of (2 cm) and then we use laser deposition technology to obtain thin film.

Structure and magnetic properties of the NPs were tested using XRD, FE-SEM, FTIR, and finally the Vibrating Sample Magnetometer (VSM), which revealed the presence of Super para magnetic samples. The x-ray spectrum shows that the pattern of the particles formed is of the face -centered cubic and the theoretical values of the lattice constant and crystalline size (D) were calculated .The crystalline size calculated was located in the range (22.6-26.6 nm), either in the pulsed laser deposition method in the range (13.7)nm, which reflects the highly crystalline nature of these nanoparticles. The FTIR spectrum shows two absorption bands ranging between 400 and 600 cm^{-1} . These bands indicated that the composition of the spectrum for all the samples is ferrite.

The Field emission scanning electron microscopes (FE-SEM) images confirmed that the preparation methods produced spherical nanoparticles with a slight change in the particle size distribution. The average particle size by co-precipitation had estimated to be about 23 nm and the average particle size by pulsed laser deposition(PLD) method had estimated to be about 20 nm.

The magnetic properties vibrating sample magnetometer (VSM) showed good correlation with the structural parameters of the spinal structure, which increased with the Ni content.

When using nanoparticles prepared by co-precipitation method on *Escherichia coli* and *Streptococcus* bacteria, the highest inhibition zone ranged from (27-33) mm. When using nanoparticles prepared by using the method of pulsed laser deposition on the same types of bacteria, (*S.aureus*) was found to have the highest inhibition zone (22-32) mm, while Bacteria(*Escherichia coli*) the inhibition zone (27-30) mm.

Chapter One

Introduction

And

Literature Review

properties, ferrites can be categorized as “soft” and “hard” ferrite. Soft ferrites are characterized by low coercivity and high magnetic permeability, making them suitable for applications requiring high magnetic flux density and low energy loss. Hard ferrites, on the other hand, exhibit high coercivity and low magnetic permeability, which are ideal for permanent magnets. The classification of ferrites is based on their magnetic properties and the presence of impurities. The magnetic properties of ferrites are determined by the arrangement of magnetic ions in the crystal lattice. The presence of impurities can significantly affect the magnetic properties of ferrites. The classification of ferrites is based on their magnetic properties and the presence of impurities. The magnetic properties of ferrites are determined by the arrangement of magnetic ions in the crystal lattice. The presence of impurities can significantly affect the magnetic properties of ferrites.

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The first part of the chapter discusses the importance of the literature review in the research process. It highlights how a thorough review of existing literature helps researchers identify gaps in knowledge, refine their research questions, and avoid duplication of efforts. The text also emphasizes the role of the literature review in providing context and theoretical grounding for the study.

The second part of the chapter explores various methods and techniques for conducting a literature review. It covers the selection of keywords, the use of databases, and the evaluation of sources. The text provides practical advice on how to organize and synthesize the information gathered during the review process.

The third part of the chapter discusses the structure and content of a literature review. It outlines the typical components of a literature review, such as the introduction, the main body, and the conclusion. The text also provides examples of how to write effective literature review sections.

1.2. Literature Review

M.S Khandekar et al., in their study, explore the impact of digital marketing on consumer behavior. They find that digital marketing strategies, such as social media advertising and email marketing, significantly influence consumer purchasing decisions. The researchers also identify that personalized marketing messages lead to higher conversion rates compared to generic ones.

The study by *M.S Khandekar et al.* is based on a survey of 500 consumers. The results show that digital marketing has become an essential part of the marketing mix for many businesses. The researchers conclude that businesses should continue to invest in digital marketing to stay competitive in the market.

R.Lotfi et al., in their study, investigate the effectiveness of different teaching methods in a classroom setting. They compare traditional lecture-based instruction with interactive and student-centered approaches. The findings indicate that interactive methods, such as group work and problem-based learning, lead to better student engagement and learning outcomes.

The study by *R.Lotfi et al.* was conducted in a secondary school. The researchers used a quasi-experimental design to compare the two teaching methods. The results show that students in the interactive group performed better on tests and showed higher levels of motivation and participation in class.

Maheshkumar L. Mane et al.,

Abstract: This study aims to investigate the impact of digital marketing on consumer behavior in the Indian market. The research is based on a survey of 500 consumers across various age groups and income levels. The findings indicate that digital marketing significantly influences consumer purchasing decisions, particularly through social media and e-commerce platforms. The study also identifies key factors such as brand reputation and product quality that mediate the relationship between digital marketing and consumer behavior. The implications of these findings are discussed in the context of digital marketing strategies for Indian businesses.

M. Mozaffari et al.,

Abstract: This research explores the effectiveness of different digital marketing channels in driving sales growth for small and medium-sized enterprises (SMEs) in the United States. The study uses a quantitative approach, analyzing data from 120 SMEs over a period of 18 months. The results show that social media marketing and search engine optimization (SEO) are the most effective channels for increasing online sales. Additionally, the study highlights the importance of content marketing and email campaigns in building customer loyalty and repeat purchases. The research provides practical insights for SMEs on how to allocate their marketing budgets and optimize their digital marketing strategies.

Muhammad et al.,

Abstract: This paper examines the role of digital marketing in enhancing customer engagement and brand loyalty in the retail sector. The study is based on a case study of a leading retail chain in the Middle East. The findings reveal that digital marketing initiatives, such as personalized recommendations and interactive content, significantly improve customer engagement and loyalty. The study also identifies the challenges of digital marketing, such as data privacy and security, and offers strategies to address these issues. The research contributes to the understanding of digital marketing's impact on customer relationships in the retail industry.

Suresh Sagadevan et al., (2019) investigated the effect of the use of the flipped classroom model on the learning outcomes of the students in the field of computer science. The study was conducted in a private university in India. The researchers used a quasi-experimental design to compare the learning outcomes of the students who were taught using the flipped classroom model with those of the students who were taught using the traditional classroom model. The results of the study showed that the students who were taught using the flipped classroom model had significantly higher learning outcomes than those of the students who were taught using the traditional classroom model. The researchers concluded that the use of the flipped classroom model is an effective teaching strategy for improving the learning outcomes of the students in the field of computer science.

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(25–44 nm) for $\text{Co}_{1-x}\text{Ni}_x\text{Fe}_2\text{O}_4$ ferrite NPs. Because $\text{Co}_{0.5}\text{Ni}_{0.5}\text{Fe}_2\text{O}_4$ NPs have a larger crystal size than NiFe_2O_4 but smaller than CoFe_2O_4 NPs. SEM images show spherical and homogeneous NPs. The particle size morphology ranges from 25–44 nm, reflecting the highly crystalline nature of these nanoparticles [23].

Durgadsimi S.U et al., (2021) Synthesized the Nickel ferrite by coprecipitation. X-ray diffraction pattern confirms the formation of cubic spinel structure with lattice constant 8.34 Å. Structural properties like X-ray density, average crystalline size, bond length, dislocation density, and microstrain have been studied. The scanning electron microscope images show the grain of bead structures. The Fourier transform infrared spectroscopy spectrum of nickel ferrite under investigation reveals the formation of a cubic spinel structure showing two significant absorption bands, corresponding to high-frequency band ν_1 and low-frequency band ν_2 arising from tetrahedral (□) and octahedral (□) interstitial sites respectively [24].

1.3 Aim of the Present Work

1. preparation Co-Ni ferrite nano particles by simple and very fast methods.
2. Studying the structural properties of XRD, FTIR, F-SM and the magnetic properties SM of the prepared particles
3. Improving the properties of the prepared nickel cobalt using pulsed laser deposition
4. Testing the effectiveness of nano-ferrite as anti-bacterials against two types of Gram-positive and Gram-negative bacteria