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Department of Physics

# *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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بسم الله الرحمن الرحيم

(قَالُوا سُبْحَانَكَ لا عِلْمَ لَنَا
إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ
الْعَلِيمُ الْحَكِيمُ﴿ ٣٢ ﴾ )

صدق الله العظيم

سورة البقرة-الآية ٣٢

# 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**

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**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 Depostion |
| MHA | Mueller Hinton Agar |
| RFA | Radio frequency ablation |
| MNPs | Micronized nanoparticals |
| MR | Magmatic Recording |
| MMONPs | magnetic metal oxide nanoparticles |

## ABSTRACT:

In this research, we prepared magnetic nano particles in format $Co_{1-x}Ni_x Fe_2 O_4$ in two methods. The first method is Co-precipitationnand 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 pulsd 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

## 1.1 Introduction

[illegible]

[illegible]

[illegible]

[illegible] μm in size, [illegible]

[illegible]

properties, ferrites can be categorized as “soft” and “hard” ferrite. Soft

## 1.2. Literature Review

***M.S Khandekar et al.,***

***R.Lotfi et al.,***

***Maheshkumar L. Mane et al.,***

***M. Mozaffari et al.,***

***Muhammad et al .,***

***Zalite et al.,*** [illegible]

***Tejabhiram et al.,*** [illegible]

***S.R. Gibben et al.,*** [illegible]

***Suresh Sagadevan et al.,*** [illegible]

***Muhammad Arshad et al.,*** **(**[illegible]**)** [illegible]

***Mikio Kishimoto et al.,*** **(**[illegible]**)** [illegible]

[illegible]

***S. V. Bhandare et al.,*** (2020) Studied changes in spinel ferrites structural and magnetic properties by doping. Magnesium the cation that occupies the tetrahedral position, rather than nickel, occupies. He created nanocrystals at octahedral sites in Co-Ni Ferrite ($Co_{0.5}Ni_{0.5}Fe_2O_4$) ceramics, where he created nanocrystals. Sol-gel $Co_{0.5}Mg_xNi_{0.5-x}Fe_2O_4$ Ceramic Powder Samples (x = 0, 0.1, 0.2, 0.3, 0.4) The spontaneous combustion method was followed by sintering at 600 °C in air for two hours. X-ray diffraction The XRD patterns of the composite samples confirm the single-phase crystalline spinel structure with Cubic symmetry. Crystal sizes were found for all samples.be in the range of 30–38 nm. Scanning electron micrographs FTIR spectra confirm the formation of the spinel phase. Through the observed vibrational bands assigned to tetrahedral ($T_d$) and octahedral (OH), interstitial complexes in the spinel structure. Magnetic measurements indicate low Saturation magnetization (Ms) with increasing Mg concentration [22].

***Sabah M. Ali Ridha et al.,*** **(**2021**)** Studied Preparing nickel-saturated ferrite nanoparticles (NPs) with the chemical formula $Co_{1-x}Ni_xFe_2O_4$ (where, x = 0, 0.5, and 1) using the sol-gel method at low temperature (200 °C). To balance the oxidizing agent, citric acid was used as a chelating agent with a mixture of nickel nitrate and ferric nitrate solutions in a 3:1 ratio .The resulting ferrite NPs were calcined at various temperatures (200, 400, 600, and 800 °C) for 4 h in the air to remove water content and unwanted impurities and to obtain a better structure than the single-phase spinel. X-ray analysis (XRD). XRD analysis shows the structure of a single-phase spinel at the nanoscale. The crystal size calculated from the FWHM of the strongest peak (311) lies in the range

(2□-44 nm) for $Co_{1-x}Ni_xFe_2O_4$ ferrite NPs. □ecause $Co_{0.5}Ni_{0.5}Fe_2O_4$ NPs have a larger crystal size than $NiFe_2O_4$ but smaller than $CoFe_2O_4$ NPs. S□M images show spherical and homogeneous NPs The particle size morphology ranges from 25-4□ nm, reflecting the highly crystalline nature of these nanoparticles [23].

***Durgadsimi S.U et al.,*** (2021) Synthesized the Nickel ferrite by co-precipitation. X-ray diffraction pattern confirms the formation of cubic spinel structure with lattice constant 8.34□□. 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 $\nu_1$and low-fre□uency band $\nu_2$ 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□-S□M 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 □ram-positive and □ram-negative bacteria