Facile Co-Precipitation Route for Magnesium Ferrites Nanostructure: Synthesis, Influence of pH Variation on Structural Properties

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Abstract: This report presents the synthesis of magnesium ferrite (MgFe₂O₄) by co-precipitation method and its subsequent characterization by using X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FTIR) techniques. XRD results confirm the formation of single phase cubic spinel structure, having lattice constant from 8.3216 Å to 8.3252 Å. An infrared spectroscopy study confirms the presence of two main absorption bands indicating tetrahedral and octahedral group complexes, within the spinel lattice. We also report hopping length (Lₐ and Lₐ), strain (ɛ) and dislocation density (ρ_D) of ferrite sample.

Keywords: Magnesium ferrite; Spinel lattice; Strain; Dislocation density; Tetrahedral and octahedral complexes.

1. Introduction

Magnetic nanoparticles (MNPs) have been intensively studied as their magnetic properties can be adjusted by altering their size, shape, and morphology [1-2]. They also possess different physical properties from macro and bulk counterparts. Magnetic nanoparticles have high potential in many applications [3] such as anti-bacteria, biomedicine, drug delivery, environmental treatment and data storage [4-5]. Ferrimagnetic oxides, or ferrites, are the materials with exceptional physical properties and high applicability in nanotechnology [6]. The ferrite materials consist of cubic spinel structure with a general chemical formula AB₂O₄, where ‘A’ tends to the divalent cations of Mg²⁺, Co²⁺, Ni²⁺, Zn²⁺, Cu²⁺ etc., and ‘B’ tends to the trivalent metal ion of Fe³⁺ [7]. Spinel ferrites own unique high electrical resistivity, high permeability, electromagnetic properties, low eddy current losses and high magnetization [8]. Single domain performance of ferrites can be increased by controlling the preparation techniques and reaction conditions [9].

Magnesium ferrites are often employed for microdevices fabrication [10-11] as a result of their low dielectric losses and high resistivity. It is a soft ferrimagnetic material in which Mg²⁺ ions have a high preference to occupy the octahedral site [12]. In MgFe₂O₄ the magnetic coupling occurs due to presence of Fe³⁺ ions, given that Mg²⁺ possesses zero magnetic moment. Thus MgFe₂O₄ possesses lower magnetic anisotropy in comparison to other spinel ferrites [13-14]. Detailed impedance spectroscopy of nano-crystalline magnesium
ferrites [15], structural properties of green synthesized magnesium ferrites were reported [16] and influence of cadmium substitution in magnesium ferrites on Structural and Mechanical properties were reported [17]. Magnesium ferrites are a promising biomaterial since they pretend to be less toxic than ferrites that contain transition metals and find economically attractive route for its preparation [18-19].

In this present work, we describe the synthesis of magnesium ferrite by environmental friendly, low cost co-precipitation method and analyzed the influence of pH 7 and pH 8 and pH 9. The structural properties of magnesium ferrite have been explored by XRD and FTIR studies. Williamson-Hall plot and size-strain plot method is also used to understand the structure of the ferrite samples.

2. Materials and Experimental Procedures

The nano magnesium ferrite (MgFe₂O₄) is synthesized by environmental friendly and low cost chemical co-precipitation method by choosing the analytical grade (Molychem) MgCl₂.6H₂O and FeCl₃. These precursors are weighed and mixed in desired stoichiometric ratio in distilled water. The reactants are stirred for nearly one hour to get clean solution. In order to maintain pH of 7, 8 and 9 drop wise ammonia solution is added and again stirred for one hour. The use of ammonia as a base is vital for co-precipitation of metal ions in their mixed solution at different pH. The reddish solution so obtained contains precipitate which is filtered to get the magnesium ferrite using AR grade filter paper. The paste from precipitate is dried at room temperature and calcined around 800 °C in muffle furnace for 5 h which will yields the nano magnesium ferrite. The process of synthesis of nano magnesium ferrite by co precipitation method is schematically as shown in Fig. 1. The X-ray diffraction patterns of the samples have been obtained on Bruker AXS D8 Advance Diffractometer (XRD) with Cu-Kα radiation, wavelength, λ= 1.5406 Å. The FTIR of the samples have been obtained on Thermo Nicolet, Avatar 370.

\[ \text{MgCl}_2.6\text{H}_2\text{O} + \text{FeCl}_3.6\text{H}_2\text{O} \rightarrow \text{MgFe}_2\text{O}_4 + n\text{H}_2\text{O} (\uparrow) + n\text{Cl}_2 (\uparrow) \]  (1)

Fig. 1. Schematic diagram of synthesis of ferrite samples by co-precipitation method.
3. Results and Discussion
3.1. XRD

The structure of sample is analyzed using the XRD analysis. The XRD image of magnesium ferrite (MgFe\(_2\)O\(_4\)) at pH = 7, 8 and 9 is presented in Fig. 2. The diffraction pattern peaks are matched with ferrite sample JCPDS card #00-22-1086, the matching of (311), (422), (511), (440), (620) and (642), reflection planes confirm cubic spinel structure. The lattice parameter of series is calculated using Equation (2) and tabulated in Table I.

\[
d = \frac{a}{(h^2 + k^2 + l^2)^{1/2}} \quad (2)
\]

where d – interplanar spacing, a-lattice parameter and (h k l) – Miller indices.

![Fig. 2. XRD graphs plot of magnesium ferrite (MgFe\(_2\)O\(_4\)).](image)

**Tab. I** XRD peak intensities for MgFe\(_2\)O\(_4\) samples (pH = 7, 8, 9) and calculated lattice parameter values.

| h k l | pH = 7 | pH = 8 | pH = 9 |
|-------|--------|--------|--------|
|       | Observed Intensity % | Observed Intensity % | Observed Intensity % |
| 311   | 100    | 100    | 100    |
| 422   | 77.5037 | 75.2569 | 76.752 |
| 511   | 59.8413 | 56.2711 | 56.7929 |
| 440   | 70.8106 | 67.8951 | 69.2107 |
| 620   | 60.8948 | 56.6586 | 56.8496 |
| 642   | 59.4075 | 54.9426 | 55.1485 |
| Lattice Parameter | 8.3216 | 8.3252 | 8.3246 |

The ionic radii, hopping length and bond length follow the same pattern. The stacking fault coefficient show very low values, representing that the peaks are not much in variation.
as compared to standard values. Average crystalline size can be calculated by Debye-Scherrer’s formula [20-21].

\[ D = \frac{K\lambda}{\beta \cos \theta} \]  

where, D - crystalline size, K - crystalline shape factor which is taken to be 0.9 in this case considering the particles to be spherical in common, \( \lambda \) - wavelength of X-ray used (1.5406 Å), \( \beta_D \) – pure diffraction broadening.

\[ (\Delta x_{\text{Ferrite}}) = \frac{8M}{Na^4} \]  

where, \( \Delta x_{\text{Ferrite}} \) - X-ray density, M- molecular weight of the sample, N- Avogadro’s number

\[ L_A = \frac{a \times \sqrt{3}}{4} \]  

\[ L_B = \frac{a \times \sqrt{2}}{4} \]  

where, \( L_A \)-The distance between magnetic ions (hopping length) in A site (tetrahedral) and \( L_B \)-the distance between magnetic ions in B site (octahedral).

\[ A-O = (u - 1/4)a\sqrt{3} \]  

\[ B-O = (5/8 - u)a \]  

where, A-O- bond length between A ion and Oxygen, B-O- bond length between A ion and Oxygen, u-oxygen ion parameter is taken as 0.382 [22] for Co-ferrite.

\[ r_A = (u - 1/4)a\sqrt{3} - r(O^{2-}) \]  

\[ r_B = (5/8 - u)a - r(O^{2-}) \]  

where, \( r_A \)-ionic radius for A site, \( r_B \)-ionic radius for B site, \( r(O^{2-}) \)-ionic radius of oxygen ion (1.35 Å).

\[ \alpha = \left[ \frac{2\pi^2}{45\sqrt{3}} \right] \frac{[\Delta 2\theta]}{\tan \theta_{hkl}} \]  

\( \alpha \)-stacking fault coefficient, \( \Delta 2\theta \)-difference in standard and observe 2θ values.

\[ \text{micro-strain}(\varepsilon) = \frac{\beta \cos \theta}{4} \]  

\[ \text{Dislocation Density } (\rho_D) = \frac{1}{D^2} \]  

\[ (\rho_D) = \frac{15\varepsilon}{aD} \]  

The crystalline size, micro strain and dislocation density for MgFe\(_2\)O\(_4\) samples (pH = 7, 8, 9) are tabulated in Table II-V.
### Tab. II Calculated values of Lattice parameter (a), volume (V), X-ray Density (Δx), crystallite size (D), strain (ε), Dislocation density ρ₀, hopping lengths (Lₐ and Lₐ₀), and Bond Length (A – O)dₐ₀, Bond Length (B – O) dₐ₀ for MgFe₂O₄ samples (pH = 7).

| Angle 20 | Lattice parameter (a) (Å) | Volume (V) (Å³) | X-ray Density (Δx) | Crystallite size (D) (Å) | Strain (ε) | Dislocation density (ρ₀) | Hopping length (Lₐ) (Å) | Hopping length (Lₐ₀) (Å) | Bond Length (A – O)dₐ₀ (Å) | Bond Length (B – O) dₐ₀ (Å) |
|----------|--------------------------|-----------------|-------------------|------------------------|------------|-------------------------|------------------------|------------------------|------------------------|------------------------|
| 35.54    | 8.3755                   | 587.53          | 4.5219            | 506.9                  | 0.000       | 684                     | 3.891                  | 6E+14                  | 3.6267                 | 2.9612                 |
| 54.14    | 8.2969                   | 571.15          | 4.6517            | 348.5                  | 0.000       | 995                     | 8.231                  | 9E+14                  | 3.5927                 | 2.9334                 |
| 57.67    | 8.3035                   | 572.51          | 4.6460            | 270.8                  | 0.001       | 280                     | 1.363                  | 7E+15                  | 3.5955                 | 2.9357                 |
| 62.55    | 8.3987                   | 592.43          | 4.4846            | 322.0                  | 0.001       | 409                     | 9.639                  | 1E+14                  | 3.6367                 | 2.9694                 |
| 72.00    | 8.2934                   | 570.42          | 4.6576            | 246.0                  | 0.001       | 409                     | 1.651                  | 8E+15                  | 3.5911                 | 2.9322                 |
| 88.56    | 8.2616                   | 563.89          | 4.7116            | 808.0                  | 0.000       | 429                     | 1.531                  | 4E+14                  | 3.5774                 | 2.9209                 |

### Tab. III Calculated values of Lattice parameter (a), volume (V), X-ray Density (Δx), crystallite size (D), strain (ε), Dislocation density ρ₀, hopping lengths (Lₐ and Lₐ₀), and Bond Length (A – O)dₐ₀, Bond Length (B – O) dₐ₀ for MgFe₂O₄ samples (pH = 8).

| Angle 20 | Lattice parameter (a) (Å) | Volume (V) (Å³) | X-ray Density (Δx) | Crystallite size (D) (Å) | Strain (ε) | Dislocation density (ρ₀) | Hopping length (Lₐ) (Å) | Hopping length (Lₐ₀) (Å) | Bond Length (A – O)dₐ₀ (Å) | Bond Length (B – O) dₐ₀ (Å) |
|----------|--------------------------|-----------------|-------------------|------------------------|------------|-------------------------|------------------------|------------------------|------------------------|------------------------|
| 35.54    | 8.3755                   | 587.53          | 4.5219            | 419.2                  | 0.00082     | 9                      | 5.6885E                | 7E+14                  | 3.6267                 | 2.9612                 |
| 54.14    | 8.2969                   | 571.15          | 4.6517            | 466.9                  | 0.00074     | 2                      | 4.5859E                | 7E+14                  | 3.5927                 | 2.9334                 |
| 57.67    | 8.3035                   | 572.51          | 4.6400            | 440.9                  | 0.00078     | 6                      | 5.1427E                | 7E+14                  | 3.5955                 | 2.9357                 |
| 62.55    | 8.3987                   | 592.43          | 4.455             | 301.1                  | 0.00115     | 1                      | 1.1025E                | 7E+15                  | 3.6446                 | 2.9758                 |
| 72.00    | 8.2934                   | 570.42          | 4.657             | 1049.9                 | 0.00033     | 0                      | 9.0705E                | 7E+13                  | 3.5911                 | 2.9322                 |
| 88.56    | 8.2616                   | 564.65          | 4.705             | 1328.1                 | 0.00026     | 1                      | 5.6866E                | 7E+13                  | 3.5790                 | 2.9222                 |

### Tab. IV Calculated values of Lattice parameter (a), volume (V), X-ray Density (Δx), crystallite size (D), strain (ε), Dislocation density ρ₀, hopping lengths (Lₐ and Lₐ₀), and Bond Length (A – O)dₐ₀, Bond Length (B – O) dₐ₀ for MgFe₂O₄ samples (pH = 9).

| Angle 20 | Lattice parameter (a) (Å) | Volume (V) (Å³) | X-ray Density (Δx) | Crystallite size (D) (Å) | Strain (ε) | Dislocation density (ρ₀) | Hopping length (Lₐ) (Å) | Hopping length (Lₐ₀) (Å) | Bond Length (A – O)dₐ₀ (Å) | Bond Length (B – O) dₐ₀ (Å) |
|----------|--------------------------|-----------------|-------------------|------------------------|------------|-------------------------|------------------------|------------------------|------------------------|------------------------|
| 35.54    | 8.3755                   | 587.53          | 4.5219            | 403.07                 | 0.000860   | 9                      | 6.1553E                | 9E+14                  | 3.6267                 | 2.9612                 |
| 54.14    | 8.2969                   | 571.15          | 4.6517            | 862.58                 | 0.000402   | 7                      | 1.3440E                | 9E+14                  | 3.5927                 | 2.9334                 |

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Tab. V Calculated average values of Lattice parameter (a), volume (V), X-ray Density (Δx), crystallite size (D), strain (ε), Dislocation density ρ_D, hopping lengths (L_A and L_B), and Bond Length (A–O)d_A, Bond Length (B–O) d_B, for MgFe_2O_4 samples (pH = 7, 8, 9).

| pH | Lattice parameter (a) | Volume (V) | X-ray Density (Δx) | Crystallite size (D) (Å) | Strain (ε) |
|----|----------------------|------------|-------------------|-------------------------|------------|
| 7  | 8.3216               | 576.32     | 4.6113            | 417.09                  | 0.000979   |
| 8  | 8.3252               | 577.09     | 4.6055            | 667.76                  | 0.000683   |
| 9  | 8.3246               | 576.96     | 4.6065            | 1324.05                 | 0.000366   |

Dislocation density (ρ_D) Hopping length (L_A) Hopping length (L_B) Bond Length (A–O)d_A, Bond Length (B–O) d_B, for MgFe_2O_4 samples (pH = 7, 8, 9).

By employing the texture coefficient, T_c (h k l) quantitative information concerning to the preferential crystal orientation can be obtained [23, 24]. The reflection intensities from each XRD pattern contain information associated to the preferential development of phases in polycrystalline material. The degree of orientation in crystal planes can be established from the expression:

\[ T_c(hkl) = \frac{\frac{1}{N} \sum \frac{I(hkl)}{I_o(hkl)}}{I(hkl)} \]  

(15)

where I and I_o stand for the observed and standard intensities and N is number of peaks. Texture analysis is tabulated in Table VI. The results advocates a growth preferred orientation in the (4 2 2) and (6 2 0) direction for all the samples.

Tab. VI Miller Indices (h k l) and calculated values of Texture coefficients for MgFe_2O_4 samples (pH = 7, 8, 9) prepared by co-precipitation method.

| h k l | pH = 7 Observed Intensity % | pH = 8 Observed Intensity % | pH = 9 Observed Intensity % |
|-------|-----------------------------|-----------------------------|-----------------------------|
| 311   | 100                         | 100                         | 100                         |
| 422   | 77.5037                     | 75.2569                     | 76.752                      |
| 511   | 59.8413                     | 56.2711                     | 56.7929                     |
| 440   | 70.8106                     | 67.8951                     | 69.2107                     |
| 620   | 60.8948                     | 56.6586                     | 56.8496                     |
| 642   | 59.4075                     | 54.9426                     | 55.1485                     |
| Lattice Parameter | 8.3216 | 8.3252 | 8.3246 |
3.1.1. Williamson hall plot and size-strain plot method

The size-strain broadening are additive components of the total breadth of a bragg peak [25]. The distinct θ dependencies laid the foundation for the separation of size and strain broadening in the analysis of Williamson and Hall. The W-H Plots are plotted using Equation 16 are plotted in Fig. 3.

$$\beta_{hkl} \cos \theta = \frac{K \lambda}{D} + 4 \varepsilon \sin \theta$$ \hspace{1cm} (16)

The evaluations of the SSP parameters are obtained by taking into account the peaks in intermediate range. This gives less weight to information from high angle reflections where the precision is usually less. The SSP plots are shown in Fig. 4 which are plotted using Equation 17. In this approximation, SSP plots assume that the “strain profile” is represented by a Gaussian function and the “crystallite size” profile by a Lorentzian [26, 27]. Accordingly, we have:

$$(d_{hkl} \beta_{hkl} \cos \theta)^2 = \frac{K \lambda}{D} (d_{hkl}^2 \beta_{hkl} \cos \theta) + \left( \frac{\varepsilon}{2} \right)^2$$ \hspace{1cm} (17)

The relationship between W-H plot and SSP has reported in Table VII.
Tab. VII Calculated values of crystallite size, micro strain and dislocation density using W-H plots, SSP and standard formula (Equation 3).

| pH | Crystallite size (in Å) | Micro strain | Dislocation density (ρD) |
|----|-------------------------|--------------|---------------------------|
|    | From W-H graph | From SSP | From formula | Micro strain | Micro strain | From formula | Micro strain |
| 7  | 3.5579 X10^-8 | 4.2272 X10^-8 | 4.1709X10^-3 | 0.0002050 | 0.11454 | 0.000979 | 5.7507 | 4.2309 |
| 8  | 2.5848 X10^-8 | 3.8622 X10^-8 | 6.6776X10^-3 | 0.00159 | 0.1198 | 0.000683 | 2.2426 | 1.8428 |
| 9  | 3.2709 X10^-8 | 3.7987 X10^-8 | 13.2405X10^-3 | 0.001597 | 0.1208 | 0.000366 | 0.5704 | 0.4980 |

Fig. 4. Size strain plot for Mg ferrites (pH= 7, 8, 9).

3.2. AFM

The microstructure of ferrite samples were shown in Fig. 5. SEM images show regular octahedron, tetrahedron, and bead like structured grains with grain size more than 2 μm. With magnesium, the grain size of the ferrites goes on increasing steadily. The high magnification image clearly shows the octahedral and tetrahedral grains. The results specify that the presence of magnesium play a key role in the formation of grain growth [23].
Fig. 5. AFM images of magnesium ferrites.

3.3. FTIR

The FTIR curves for MgFe$_2$O$_4$ at pH 7, 8 and 9 are shown in the Fig. 6. The spectra were recorded at room temperature in the frequency range of 400–800 cm$^{-1}$. The FTIR curves for MgFe$_2$O$_4$ series with pH = 7, 8, 9 shows two major peaks near 501 cm$^{-1}$ and 403 cm$^{-1}$. The wave numbers of respective peaks are tabulated in Table VIII. The higher frequency band ($v_1$) (500-502 cm$^{-1}$) and lower frequency band ($v_2$) (402 – 404 cm$^{-1}$) for MgFe$_2$O$_4$ are assigned to the tetrahedral and octahedral sites respectively in a spinel structure [28-29]. According to Waldron’s classification [30], the vibrations of the unit cell of cubic-spinel can be constructed in the tetrahedral (A) site and octahedral (B) site. So, the absorption band $v_1$ (500 cm$^{-1}$, 501 cm$^{-1}$, 502 cm$^{-1}$) is caused by the stretching vibration of the tetrahedral metal-oxygen bond, and the absorption band $v_2$ (402 cm$^{-1}$, 403 cm$^{-1}$, 404 cm$^{-1}$) is caused by the metal-oxygen vibrations in octahedral sites [31].

The values of $v_1$ are higher than those of $v_2$ indicating that the normal mode of vibration of the tetrahedral complexes is higher than that of the corresponding octahedral site. This may be due to the shorter bond length of the tetrahedral site than that of the octahedral site. The absorption bands $v_1$ and $v_2$ are found in the expected range and the difference in band
position is due to the difference in the Fe$^{3+}$-O$^{2-}$ for the octahedral and tetrahedral complexes [28-31]. The positions of absorption bands are pH dependent.

![FTIR curves of magnesium ferrites.](image)

**Fig. 6.** FTIR curves of magnesium ferrites.

| pH | v2 (cm$^{-1}$) | v1 (cm$^{-1}$) |
|----|---------------|---------------|
| 7  | 403           | 501           |
| 8  | 402           | 500           |
| 9  | 404           | 502           |

**Tab. VIII** FTIR peaks for MgFe$_2$O$_4$ series with pH = 7, 8, 9.

4. Conclusion

The magnesium ferrites with pH = 7, 8 and 9 samples were successfully synthesized by co-precipitation method. The X-ray diffraction results for the samples of magnesium ferrites showed the formation of single phase cubic spinel structure, having lattice constant from 8.3216 Å to 8.3252 Å. We have also discussed X-ray Density ($\Delta x$), crystallite size (D), strain (ε), Dislocation density ($\rho_D$), hopping lengths ($L_A$ and $L_B$), and Bond Length (A-O) $d_A$, (O, Bond Length (B-O) $d_B$. The planes (4 2 2) and (6 2 0) showed prominent preferential orientation for all the pH samples. We have correlated crystalline structure by Williamson-Hall plot and Size-strain plot methods. The FTIR curves for magnesium ferrites series shows two major peaks near 403 cm$^{-1}$ and 501 cm$^{-1}$ which are assigned to the tetrahedral and octahedral sites respectively in a spinel structure.

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5. References

1. S. Jin, G.H. Jun, S. Jeon, S.H. Hong, Nano Convergence, 3 (2016) 8.
2. Mishra, Materials Research Bulletin, 108 (2018) 207-213.
3. R. A. Ismail, G. M. Sulaiman, S. A. Abdulrahman, T. R. Marzoog, Mater. Sci. Eng. C, 53 (2015) 286-297.
4. S. C. Tang, I. M. Lo, Water Res., 47 (2013) 2613-2632.
5. T. Kaewmanee, S. Wannapop, A. Phuruangrat, T. Thongtem, O. Wiranwetchayan, W. Promnopas, S. Sansongsiri, S. Thongtem, Inorganic Chemistry Communications, 103 (2019) 87-92.
6. L. Andjelkovic, M. Suljagic, M. Lakic, D. Jeremic, P. Vulic, A. S. Nikolic, Ceramics International, 44 (2018) 14163-14168.
7. N. Boda, G. Boda, K. C. Babu-Naidu, M. Srinivas, K. M. Batoo, D. Ravinder, A. P. Reddy, Journal of Magnetism and Magnetic Materials, 473 (2019) 228-235.
8. V. G. Harris, Modern microwave ferrites, IEEE Trans. Magn., 48 (3) (2012) 1075-1104.
9. M. A. Dar, et al., J. Alloy. Comp., 523 (2012) 36-42.
10. V. Sepelak, D. Baabe, F. J. Litterest, K. D. Becker, J. Appl. Phys., 88 (2000) 5884-5893.
11. M. P. Horvath, J. Magn. Mater., 215 (2000) 171-183.
12. P. Jadoun, J. Sharma, S. Kumar, S. N. Dolia, D. Bhatnagar, V.K. Saxena, Ceramics International, 44 (2018) 6747-6753.
13. D. Varshney, K. Verma, A. Kumar, J. Mol. Struct., 1006 (2011) 447-452.
14. Ehi-Eromosele Cyril Osereme, Ita Benedict Iserom, Iweala Emeka Eze Joshua, Synthesis, Microstructure and Magnetic Properties of Nanocrystalline MgFe₂O₄ Particles: Effect of Mixture of Fuels and Sintering Temperature, Science of Sintering, 48 (2016) 221-235.
15. Dalibor L. Sekulić, Zorica Z. Lazarević, Čedomir D. Jovalekić, Aleksandra N. Mihutinović, Nebošja Z. Romčević, Impedance Spectroscopy of Nanocrystalline MgFe₂O₄ and MnFe₂O₄ Ferrite Ceramics: Effect of Grain Boundaries on the Electrical Properties, Science of Sintering, 48, 1 (2016) 17-28.
16. N. M. Deraz, Facile and Eco-Friendly Route for Green Synthesis of Magnesium Ferrite Nano Particles, Science of Sintering, 52 (2020) 53-65.
17. S. L. Galagali, R. A. Patil, R. B. Adaki, C. S. Hiremath, S. N. Mathad, R. B. Pujar, “Influence of Cadmium substitution in magnesium ferrites on Structural and Mechanical properties”, Science of Sintering, 50, 2 (2018) 217-223.
18. M. Lakic, L. Andjelkovic, M. Suljagic, P. Vulic, M. Peric, P. Iskrenovic, I. Krstic, M. M. Kuraica, A. S. Nikolic, Optical Materials, 91 (2019) 279-285.
19. S. S. Yattinahalli, S. B. Kapatkar, S. N. Mathad, J. Nano- Electron. Phys., 7(4) (2015) 04096-04099.
20. S. S. Yattinahalli, S. B. Kapatkar, N. H. Ayachit, S. N. Mathad, Int. J. Self Propag. High Temp. Synth., 22 (3) (2013) 147-150.
21. S. N. Mathad ,V. Puri “Structural and dielectric properties of SrₓBa₁₋ₓNb₂O₆ ferroelectric ceramics”Archives of Physics Research, 3, 2 (2012) 106-115.
22. T. Pathan, S. N. Mathad, A. M. Shaikh, Int. J. Self Propag. High Temp. Synth. 23 (2) (2014) 112-117.
23. A. B. Kulkarni, S. N. Mathad, Mater. Sci. Energy Technol., 2 (2019) 455-462.
24. S.N. Mathad, R.N. Jadhav, N.D. Patil, V. Puri, Int. J. Self-propagating High Temp. Synthesis, 22 (4) (2013) 180–184.
25. K. Zak, M.E. Abrishami, W.H. A. Majid, R. Yousefi, S.M. Hosseini, Ceram. Inter., 37 (2011) 393–398.
26. M. A. Tagliente, M. Massaro, Phys. Res. B, 266 (2008) 1055.
27. Y. T. Prabhu, K. V. Rao, V. S. S. Kumar, B. S. Kumari, World J. Nano Sci. Eng., 4 (2014) 21-28.
28. M. K. Rendale, S. N. Mathad, V. Puri, Microelectronics International, 34(2) (2017) 57-63.
29. M. R. Patil, M. K. Rendale, S. N. Mathad, R. B. Pujar, International Journal of Self Propagating High-Temperature, 26 (1) (2017) 33-39.
30. R. D. Waldron, Phys. Rev., 99(6) (1953) 1727-1735.
31. S. Pujar, A. B. Kulkarni, S. N. Mathad, C. S.Hiremath, M. K. Rendale, M. R. Patil, R. B. Pujar, Synthesis, Structural, FTIR and Electrical properties of Cu,Cox,Fe2O4(x=0.0,4,1) Prepared by Solid State Method, International Journal of self propagating high temperature synthesis, July, 27, 3(2018) 174-179.

**Саметак:** Овај рад презентује синтезу магнезијум ферита (MgFe2O4) методом копреципитације и карактеризације употребом рендгенске дифракције (XRD) и инфрацрвена спектроскопија са Фуријеовом трансформацијом (FTIR). XRD резултати су потврдили формирање једне фазе, спинела кубне структуре, са решетком 8.3216 Å до 8.3252 Å. Инфрацрвена спектроскопија је потврдила присуство две главне абсорпционе траке указујући на тетраедарску и октаедарску групу комплекса унутар решетке спинела. Извestiли смо, такође, напрезање (ε) и густину дислокација (ρD) феритног узорка.

**Кључне речи:** магнезијум ферит, решетка спинела, напрезање, густина дислокација, тетраедарски и октаедарски комплекси.

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