Facile and Eco-Friendly Route for Green Synthesis of Magnesium Ferrite Nano Particles

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Abstract:
Magnesium ferrite (MgFe₂O₄) nano-particles were synthesized by using both the ceramic method and egg white assisted green synthesis method. The ceramic method carried out at different temperatures while the combustion method achieved at 300 °C for quarter-hour with various amounts of egg white. The green synthesis method was found to be a simple and cost-effective method compared to the ceramic method. Significant effects of the calcination temperatures and concentration of egg white on the observed phases, sizes, lattice parameters and morphological properties of the as-synthesized nanoparticles have been studied. Investigation of the structural and morphological characteristics of the as-prepared samples was determined by XRD and SEM techniques, respectively. However, the relative atomic abundance of Mg, Fe and oxygen species present in various solids were determined by the EDX technique. The results display the nanometer size and partially inverse spinel structure of MgFe₂O₄ studied.

Keywords: Magnesium ferrite; XRD; SEM; EDX.

1. Introduction

Synthesis routes of materials are the most important factors affecting the properties of these materials. There are many factors that control each method of the as synthesized materials. From there, Marathon begins to choose between the best methods for the preparation of materials. In general, the best methods of preparation are characterized by several advantages, such as that the method is simple, inexpensive and environmentally friendly and preferably methods that give the largest amount of product or material required [1-3].

Ferrites, both soft and hard, are a large class of oxides used in many technological applications because of their excellent magnetic and electrical properties [4]. Ferrites can be obtained in three different crystal systems (spinels, garnets, and hexaferrite) by many routes. Indeed, the feasibility to prepare a virtually unlimited number of solid solutions opens led to tailor their properties for many applications [5].

Magnesium ferrite (MgFe₂O₄) is one of the most important ferrites. MgFe₂O₄ nanoparticles consisted entirely of the tetrahedral and octahedral cation sites. Indeed, these sites are coordinated and occupied by divalent Mg²⁺ and trivalent Fe³⁺ [6]. So, it has a cubic structure of normal spinel-type and is a soft magnetic n-type semiconducting material. According to the preparation method, MgFe₂O₄ could be partial inverse spinel ferrite (Mg²⁺₁−δ Fe³⁺δ)[Mg²⁺δ Fe³⁺₂−δ]O₄ depending upon the distribution of cations (Mg²⁺ and Fe³⁺), where δ

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represents the degree of inversion of cation in the cubic structure [7, 8]. The fascinating properties of MgFe₂O₄ nano-particles such as their high stability, cost-efficiency, and non-toxicity brought about numerous applications of these particles such as sensors, high-density magnetic recording, heterogeneous catalysis, hyperthermia, and magnetic technologies [9-11].

Fabrication of magnesium ferrite had achieved by using different physical and chemical methods such as micro-emulsion, co-precipitation, mechano-chemical, sol-gel and combustion routes [12-15]. In our quest to expand green chemistry, preserve the environment, streamline materials preparation, and combine all the advantages to be achieved at the industrial and environmental levels, we will resort to using natural materials such as egg white to achieve the desired simplicity in the material preparation process. The use of egg white simplified the economical synthesis of nanocrystalline ceramic particles. Indeed, egg white has gelling, foaming and emulsifying characteristics [16-18]. However, egg white used as a binder gel for shaping material especially bulk and ceramics due to its solubility in water and its ability to associate with metal ions in solutions [19, 20]. In order to emphasize the importance of using natural materials in the preparation of ceramic materials, we will deal with the process of preparing the same materials in the traditional way, which is called the ceramic method.

In this article, we will report on a comparative study of structural and morphological characteristics of magnesium ferrite prepared by using ceramic and combustion routes. Also, we have attempted to study the effects of changing the amount of fuel on the formation, structural and morphological properties magnesium ferrite.

2. Materials and Experimental Procedures
2.1. Preparation routes
2.1.1. Reagents

The magnesium ferrite (MgFe₂O₄) was synthesized using analytical Fe(NO₃)₃.9H₂O, Mg(NO₃)₂.6H₂O and fresh egg white as starting materials. The chemicals employed in the present work were of analytical grade supplied by Prolabo Company. The egg white was extracted from the eggs of local chicken.

2.1.2. The first method is the combustion route

In this method subsequently, 2.56g Mg(NO₃)₂.6H₂O and 8.08g Fe(NO₃)₃.9H₂O (a mole ratio corresponding to the nominal composition of Mg:Fe ratio of 1:2) were added slowly to different amounts of egg white (0, 3 and 6 ml, respectively) with vigorous stirring at room temperature to obtain a well-dissolved solution. Throughout the whole process described above, no pH adjustment was made. Then, the mixed solution was evaporated by heating on a hot plate at 80 °C with vigorous stirring until a dried precursor was obtained. When a container temperature was reached to 300 °C for quarter-hour, a lot of foams produced and spark appeared at one corner which spread through the mass, yielding voluminous and fluffy products. The dried products were crushed into powder using a mortar and pestle. The as-synthesized solids were designated S₀, S₃ and S₆ for the samples treated with 0, 3 and 6ml egg white, respectively.

2.1.3. The second method is the ceramic route.

The previous masses of iron and magnesium nitrates were mixed with each other. The mixed precursors were concentrated in a porcelain crucible on a hot plate at 300 °C for quarter-hour. The crystal water was gradually vaporized during heating and when a crucible
temperature was reached, the mixed solids calcined to produce powder in the container. The final product calcined at 700 and 900 °C for 2h. These solids were designated S7 and S9 for the samples calcined at 700 and 900 °C, respectively. A general flowchart of the synthesis process is shown in Fig. 1.

Fig. 1. Experimental flow chart for the synthesis of MgFe$_2$O$_4$ nanopowders by the ceramic route and egg white assisted green method.

2.2. Characterization techniques

X-ray measurement of various mixed solids was carried out using a BRUKER D8 advance diffractometer (Germany). The patterns were run with Cu K$_\alpha$ radiation at 40 kV and 40 mA with scanning speed in 2θ of 2 ° min$^{-1}$.

The crystallite size of MgFe$_2$O$_4$ present in the investigated solids was based on X-ray diffraction line broadening and calculated by using the Scherrer equation [21]:

$$d = \frac{B\lambda}{\beta \cos \theta}$$

where d is the average crystallite size of the phase under investigation, B is the Scherrer constant (0.89), λ is the wavelength of X-ray beam used, β is the full-width half maximum (FWHM) of diffraction and θ is the Bragg's angle. The lattice parameters (a) were calculated according to the equation [21]:

$$a = d_{ab}(h^2+k^2+l^2)^{1/2}$$

The X-ray density; $D_x$ was calculated using the relation [22]:

$$D_x = \frac{8M}{Na^3}$$

where 8 represents the number of molecules in a unit cell of spinel lattice. M is molecular weight, N is Avogadro’s number, as is the lattice parameter. The micro-strain (ε), ionic radii ($r_A$ and $r_B$) and bond lengths (A–O and B–O) on tetrahedral (A) sites and octahedral (B) sites of cubic spinel structure are calculated by using the equations suggested by Standely [23].
Scanning electron micrographs (SEM) were recorded on JEOL JAX-840A electron micro-analyzer. The samples were dispersed in ethanol and then treated ultrasonically in order to disperse individual particles over gold grids.

Energy-dispersive X-ray analysis (EDX) was carried out on a Hitachi S-800 electron microscope with an attached kevex Delta system. The parameters were as follows: accelerating voltage 15 kV, accumulation time 100s, window width 8 μm. The surface molar composition was determined by the Asa method, Zaf-correction, Gaussian approximation.

3. Results
3.1. XRD analysis
3.1.1. Determination of the crystalline phases

![XRD patterns](image)

Fig. 2. XRD patterns of the S0, S3, S6, S7 and S9 samples.

The XRD patterns of S0, S3, S6, S7 and S9 specimens were determined and shown in Fig. 2. Inspection of this figure and Table I revealed that: (i) The S0 sample consisted entirely of a mixture of moderate crystalline α-Fe$_2$O$_3$ as a major phase and MgO as a minor phase. (ii) The S7 specimen consisted entirely of moderate crystalline MgFe$_2$O$_4$ as a minor phase and MgO as a major phase. This result is similar to MgO-MgFe$_2$O$_4$ composite prepared by Han et al. [24]. In other words, the calcination of MgFe mixed oxides at 700 °C for 2h brought about formation of magnesium ferrite with an increase in the crystallinity of MgO. This indicates that the heat treatment stimulates the solid state reaction between MgO and Fe$_2$O$_3$ yielding MgFe$_2$O$_4$. However, an increase of calcination temperature from 700 to 900 °C enhances the formation of magnesium ferrite with subsequent disappear of magnesium oxide as shown in the S9 sample. In other words, complete conversion of the reacting oxides was observed via the heat treatment of the reacting oxides (MgO and α-Fe$_2$O$_3$) at 900 °C for 2h yielding MgFe$_2$O$_4$ as a single phase. In addition, the increase in the calcination temperature from 700 to 900 °C led to a progress increase in the peak height at d-spacing 2.52 Å. (iii) In addition, egg white treatment of the precursors of mixture containing magnesium and ferric nitrates followed by heating on hot plate in air at 300 °C for quarter hour resulted in solid state reaction between these precursors yielding MgFe$_2$O$_4$. This finding indicates that the presence of small amount of egg white in the mixture of Mg and Fe nitrates followed by heating at 300 °C for 15min led to formation of MgFe$_2$O$_4$ together magnesium oxide. (iv) The augmentation
in the amount of egg white led to the complete conversion of un-reacted oxides with 
subsequent formation of a well crystalline spinel structure of magnesium ferrite as the single-
phase. In other words, 6ml egg white treatment resulted in the complete conversion of both 
MgO and α-Fe₂O₃ to MgFe₂O₄. However, 6 ml egg white treatment brought about an increase 
in the peak height of the previous phase with a maximum value of about 78 %. (v) The 
increase in the heat treatment from 700 to 900 °C resulted in a slightly increase in the 
crystallite size (d) of the as-synthesized Mg ferrite. Opposite behavior was observed in the 
case of the egg white treatment. Indeed, the stimulation effect of egg white or calcination 
temperature in ferrite formation depends upon an effective increase in the mobility of Mg and 
Fe cations taking part in the formation of MgFe₂O₄. There are different parameters affect the 
mobility of cations taking part in ferrite formation such as preparation temperature and 
concentration of fuel added [17-19].

Tab. I Effects of the preparation temperature and the amount of egg white on the values of 
crystallite size and the ratio of I₂₂₀/I₄₄₀ for the spinel magnesium ferrite.

|            | d (nm) | Preparation temperature (°C) | Egg white (ml) | Solids |
|------------|--------|-----------------------------|----------------|--------|
| S3         | 3      | 300                         | 20             | 0.5833 |
| S6         | 6      | 300                         | 18             | 0.7671 |
| S7         | 0      | 700                         | 20             | 0.4878 |
| S9         | 0      | 900                         | 25             | 0.3271 |

3.1.2. Cation distribution of the as-synthesized ferrite

From our experience and the literature, the intensities of planes (220) and (440) can 
be taken as an indicator of the measure of cation distribution involved in the ferrite system on 
tetrahedral and octahedral sites, respectively [25-27]. The ratio between the intensities of 
(220) and (440) planes (I₂₂₀/I₄₄₀) is listed in Table I. It can be observed from Fig. 2 that the 
intensities of the previous planes increase with an increase of both the amount egg white from 
3 to 6 ml and also the calcination temperature from 700 to 900 °C. This increase has occurred 
in a different manner. This suggested that redistribution of cations on tetrahedral and 
octahedral sites has occurred. However, the increase in I₄₄₀ for the S9 sample is greater than 
that for the S6 sample. In other words, the maximum values in the increase in the peak height 
for the peaks at d- spacing 1.48 Å related to the previous plane attained 103 and 161 % for the 
sample treated with 6ml egg white and that calcined at 900 °C, respectively. Indeed, XRD 
measurements referred to the presence of the MgFe₂O₄ phase in S3 and S7 samples together 
un-reacted MgO phase which disappeared in S6 and S9 samples. This indicates to the 
incorporation of MgO in the lattice of cubic spinel MgFe₂O₄ especially in the octahedral (B) 
site. These findings confirm that Mg²⁺ ions have preferentially occupied the B sites [27]. On 
the other hand, the increase (166 %) in the peak height for the peaks at d -spacing 2.97 Å 
related to (220) plane could be attributed to the migration of excess amounts of Mg cations to 
tetrahedral (A) site. The migrated amounts of Mg cations in the case of the S9 sample are 
smaller than that in the case S6 sample. The comparison between the increases in the ratio of 
I₂₂₀/I₄₄₀ due to the different treatments confirms this suggestion as shown in Tab. I. Indeed, the 
increase in the ratio of I₂₂₀/I₄₄₀ due to egg white treatment is greater than that at heat treatment. 
This confirms that the Mg ferrite has a partially inverse spinel structure especially the S3 and 
S6 samples.
3.1.3. Lattice parameters of the as-synthesized ferrite

An investigation of an X-ray data enable us to determine the effects of both calcination temperature and the amount of egg white on the structural parameters of MgFe₂O₄ solid such as the lattice constant (a), unit cell volume (V), X-ray density (Dₓ), micro-strain (ε), ionic radii (rₐ and rₐ), and bond lengths (A–O and B–O) on tetrahedral (A) sites and octahedral (B) sites of cubic spinel structure [23]. The estimated values of various structural parameters are given in Tab. II. It can be seen from this table that the rise in calcination temperature brought about an increase in the values of all structural parameters except for the X-ray density. The observed increase in the mentioned parameters could be attributed to grain growth and/or the redistribution of cations among octahedral and tetrahedral sites of spinel Mg ferrite nanoparticles [12-14]. Opposite behavior was observed in the samples prepared using egg white assisted green synthesis. This observation could be attributed to the capping effect of egg white on the as-prepared particles with subsequent control in their sizes [27]. So, the egg white assisted preparation route resulted in size-controlled synthesis for different oxides.

| Solid | a (nm) | V (nm³) | Dₓ (g/cm³) | rₐ (nm) | rₐ (nm) | A–O (nm) | B–O (nm) | Strain (ε) |
|-------|-------|--------|-----------|--------|--------|----------|---------|-----------|
| S3    | 0.8373 | 0.5870 | 3.407     | 0.0564 | 0.0684 | 0.1914   | 0.2034 | 0.0434    |
| S6    | 0.8357 | 0.5836 | 3.427     | 0.0560 | 0.0681 | 0.1910   | 0.2031 | 0.0458    |
| S7    | 0.8360 | 0.5843 | 3.423     | 0.0561 | 0.0681 | 0.1911   | 0.2031 | 0.0129    |
| S9    | 0.8398 | 0.5923 | 3.377     | 0.0570 | 0.0691 | 0.1920   | 0.2041 | 0.0481    |

3.2. SEM investigation

The surface and grain morphology of spinel magnesium ferrite are studied by scanning electron microscopy (SEM). SEM images of the S0, S3, S6, S7 and S9 samples are given in various Figures from 3a to Fig. 3e, respectively. The SEM micrographs for the S0, S7 and S9 samples showed spherical small particles in addition to large particles as shown in figures 3a, 3d and 3e. The presence of large particles could be attributed to the grain growth depending upon the elevated temperature of preparation. XRD measurements confirm this result. In addition, these samples are seemingly porous and agglomerated with the nano entities. However, Figures 3b and 3c show that the S3 and S6 samples essentially consist of irregularly cubic particles with homogenous grains and uniformly distributed. Little agglomeration is unavoidable in the S3 and S6 specimens. This suggested that the egg white assisted biosynthesis for magnesium ferrite nano-particles is better than the ceramic method for preparing these particles.

Generally, the samples seem to be homogenous with somewhat agglomeration and size less than 40 nm. The porosity of the as-prepared materials develops at the base of the neck [26]. The neck growth is the consequence of the migration of vacancies from pore or neck to the neck boundary. This behavior could be attributed to unequal diffusion rates. The growth of holes or pores is followed by the growth of granules or grains. These findings resulted in the characteristic microstructure of Mg ferrite via the residual porosity in intragranular space [28].
3.3. EDX analysis

It is well known that EDX technique supplies the effective atomic concentration of different constituents of the solids investigated present on their top surface layers. Figures from 4a and 4e show the energy dispersive X-ray analysis (EDX) spectrum for the S0, S3, S6, S7 and S9 samples, whereas Table III gives the quantitative estimation of elements obtained directly from spectrum through its weight percentage. In the EDX spectra, no impurity element is seen, except Mg, Fe and O. In other words, the results confirmed the presence of the required elements in the prepared magnesium ferrite with almost all the peaks associated with Mg, Fe and O elements.

Investigation of Table III revealed that: (i) the surface Mg/Fe ratio in the solids was strongly dependent on the preparation method. (ii) The increase in the calcination temperature from 700 to 900 °C resulted in an increase in the surface Mg species. The extent of the increase in surface Mg/Fe ratio was 6.7 %. XRD measurements confirm this observation depending on the octahedral (B) site involved in the cubic spinel MgFe₂O₄ lattice is located at
the surface of the crystal [12-14]. (ii) Egg white treatment brought about an increase in the surface Mg/Fe ratio. But, this increase was smaller than that for the sample prepared by the ceramic method. This could be attributed to the migration of small amounts of magnesium ion to tetrahedral (A) site involved in spinel Mg ferrite prepared by ceramic method and vice versa in case of egg white assisted green synthesis. This result has coincided with XRD measurements about the formation of partially inverse spinel Mg ferrite with the redistribution of cations.

**Fig. 4.** EDX patterns of: (a) S0; (b) S3; (c) S6; (d) S7 and (e) S9 samples.
Tab. III The composition of the Mg/Fe system measured by EDX analysis.

| Solids | Elements | Atomic abundance (%) | Surface Mg/Fe Ratio |
|--------|---------|-----------------------|---------------------|
| S0     | Mg      | 8.84                  | 0.1332              |
|        | Fe      | 66.33                 |                     |
|        | O       | 24.82                 |                     |
| S3     | Mg      | 3.52                  | 0.0490              |
|        | Fe      | 71.74                 |                     |
|        | O       | 24.73                 |                     |
| S6     | Mg      | 4.05                  | 0.0521              |
|        | Fe      | 77.77                 |                     |
|        | O       | 18.18                 |                     |
| S7     | Mg      | 8.85                  | 0.1324              |
|        | Fe      | 66.32                 |                     |
|        | O       | 24.83                 |                     |
| S9     | Mg      | 12.35                 | 0.1997              |
|        | Fe      | 61.82                 |                     |
|        | O       | 12.35                 |                     |

4. Discussion

Ferrite based materials were prepared by using various physical and chemical routes. These routes have different advantages with some disadvantages such as the large initiation of chemicals, energy, and equipment. This means that these methods suffer from complexity, toxicity with the time-consuming [29, 30]. In contrast, green methods for preparing the materials are much easier and safer to use, and biosynthesis of nano-particles is still a new scheme and the outcome is yet to be studied.

In fact, there are many attempts in the field of green synthesis of MgFe₂O₄, but the new in this research is to provide the step of heating at high temperatures for long or short periods. However, the amount of extracted egg-white aqueous solution is small for the fabrication of magnesium ferrite. Indeed, egg white assisted auto-combustion of the precursors brought about an increase in the mobility of reacting cations yielding MgFe₂O₄. The combustion factors such as fuel concentration affect the thermal diffusion of Mg and Fe cations through the ferrite film which covers the surfaces of grains of reacting oxides and acts as an energy barrier for the ferrite formation. This diffusion is the rate-determining step for the propagation of solid-state reaction between Mg and Fe oxides [12-14]. Comparing egg white assisted green synthesis with different routes shows appreciable advantages such as low cost, less sintering, environmentally friendly, facile and simple preparation of composite in nano-scale homogeneity. This method has not sensitive and complicated controlling parameters to be used in an industrial scale. The mechanism of magnesio-ferrite formation depends upon diffusion of the reacting cations through the early thin ferrite layer. The author suggested the formation of early thin ferrite layer around grains both ferric and magnesium oxides [12-14]. An increase of the diffusion through this layer brought about an increase in the MgFe₂O₄ formation [12-14, 31, 32].

The mechanism of cation distribution depends on energy stabilization in the structure via the lowest state of energy. In fact, Mg²⁺ ions have preferentially occupied the B sites [26]. In light of this tendency, some Fe³⁺ ions will migrate to the tetrahedral (A) site. So, MgFe₂O₄ particle has an inverse spinel structure. In other words, Fe³⁺ ions have a tendency to be located in tetrahedral sites with making a strong bond with O²⁻ ions in terms of electro-negativity differences and reach the lowest state of energy. This type was observed in the samples.
prepared by using the ceramic method. But we often find magnesium ferrites have a partially inverse or random spinel structure depending on the redistribution of cations involved in the structure formation. This kind was observed in the specimens synthesized by egg white mediated green method.

The evidence on the author's observations about the mechanism of cation distribution depends upon XRD and EDX measurements. The author suggests that there is a substitution of Fe$^{2+}$ ions at the B site by Mg$^{2+}$ ions depending upon magnesium ions were preferred this site. This substitution may be accompanied by the conversion of Fe$^{2+}$ ions to Fe$^{3+}$ ions. These processes resulted in a contraction in the crystal lattice. Indeed, Mg$^{2+}$ and Fe$^{3+}$ ions have ionic radii less than that of Fe$^{2+}$ ions. Moreover, the decrease in the values of d, a, r$_A$ and r$_B$ confirms the previous suggestions. In addition, the increase in both the peak height at d = spacing at both 1.48 Å and 2.97 Å supported this observation. So, we can be concluded that MgFe$_2$O$_4$ prepared by egg white assisted green method resulted in a partially inverse or random spinel structure. It is obvious that our speculations are well consistent with the experimental values of the lattice parameters. In contrast, the ceramic synthesis of magnesium ferrite brought about an increase in the values of d, a, r$_A$ and r$_B$. This could be attributed to abnormal grain growth depending upon a few grains grow much larger than the remaining majority as shown in Figures 3d and 3e [33]. Indeed, the increase in the calcination temperature from 700 to 900 °C led to an increase in the micro-strain value of the as-prepared solid. This indicates to change in the topological structure of the as-synthesized ferrite depending on the preparation method. From this point of view, various trajectories of grain size versus density result. The heat treatment resulted in an increase in the crystallite size with subsequent a decrease in the density of magnesium ferrite. In addition, this treatment led to a loss in the content of oxygen for the S9 sample.

In this study, we assume that egg whites have many advantages in the production of Mg ferrite nanoparticles easily and quickly compared to traditional methods. Depending upon the protein nature of egg white, it has unique characteristics like gelling, foaming and emulsifying [20]. We propose a tentative mechanism for the formation of Mg ferrite nanoparticles comprising the following steps. Egg white has been extensively used as a binder as well as gum informing the shape of bulky and porous ceramics due to its ability to associate with metal ions in a solution and be easily burnt out later [34]. Indeed, the egg white foaming power is due to the combined activities of various proteins like globulins, conalbumin, ovomucin and ovalbumin [35]. So, the freshly extracted egg white acts as a matrix for trapping metal ions, generating a gelled precursor [36]. In other words, egg white proteins have a great capacity to bind with metal ions. The resulting combination is known as an organic-inorganic complex. These complexes formed with the transition metals, copper, zinc, mercury and silver, tend to be very strong chemically and can occur in conjunction with several amino acid functional groups. However, the lower surface tension of proteins contributes to the small-bubble formation and smooth texture [19]. Ovomucin forms an insoluble film around the air bubbles and stabilizes foam [20]. Moreover, the transferrin or ovotransferrin (also known as conalbumin) is an iron-binding protein. In other words, transferrins are iron binding transport proteins which can bind Fe$^{3+}$ ions. Heating the mixture of egg white and metal nitrates at 80 °C with stirring resulted in a release of the naturally entrapped carbon dioxide with subsequent an increase in the binding ability of amino acids with metal ions due to an increase in the pH. During the drying process, no one can ignore the possibility of the formation of polypeptide and the completion of metal ion binding [37]. The augmentation in the heat temperature to 300 °C for 15 min brought about the decomposition of the protein contents and mineralizes the matrix to produce the desired nanocrystalline Mg ferrite.
4. Conclusion

Polycrystalline MgFe$_2$O$_4$ has been successfully fabricated by using both the ceramic method and egg white assisted green synthesis method. The X-ray diffraction results for the samples showed the formation of a single-phase cubic spinel structure at 900 °C and also with the presence of egg white followed by heating at 300 °C. The lattice constant (a) of the as-synthesized particles found to increase by increasing the calcination temperature. Opposite behavior was observed in the presence of egg white. We have also discussed morphology, bond length (A-O and B-O), density and mechanical properties (strain) for the as-prepared MgFe$_2$O$_4$. The results showed that the investigated samples contain Mg, Fe and O elements without the presence of impurities.

5. References

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Саметак: Нано честице магнезијум-ферита (MgFe<sub>2</sub>O<sub>4</sub>) добијене су на два начина, керамичком методом и еко-методом уз помоћ беланца из јајета. Керамички метод подразумева различите температуре, док је метод сагоревања на 300 °C током 15 минута уз различите количине беланца. Еко-метод синтезе је једноставан и јефтин у поређењу са другим, керамичким. Проучаван је значајан ефекат температуре калцинације и концентрације беланца на добијене фазе, параметре решетке и морфолошка својства добијених нано-честица. Испитивања структурних и морфолошких својстава припремљених узорака вршено је техникама XRD и SEM. Релативна атомска заступљеност Mg, Fe и кисеоника у узорцима утврђена је EDX техником. Резултати указују на нанометарску величину и деломично инверзну структуру спинела MgFe<sub>2</sub>O<sub>4</sub>.

Кључне речи: магнезијум-ферит, XRD, SEM, EDX.

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