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Study of Structural Changes of $BaFe_2O_4$ Barium Coefficient by Co-Precipitation with Temperature Change

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Research Summary
This study aims at preparing the compound $BaFe_2O_4$ in a method of co-sedimentation in aqueous solutions from the raw materials and then studying its structure and characteristics. The results of the DTA showed that the dehydration is done at 182.98^0C and at 266.36^0C, X-ray that the binary sentence began to form at 500^0C, and we observed a clear increase in the intensity of the peaks and this indicates the clear growth of the crystals with high temperature.
Keywords: CO-Precipitation, Barium ferrite, $BaFe_2O_4$

Introduction:
Presenting new electrolytic materials with ideal chemical or optical properties and making their magnetic properties perfect is one of the most challenging issues of the moment. Iron compounds are an important group of magnetic materials because of their widespread use in several low-to-high-energy applications including electronics and short-wave magnetism delivery devices. Among the nanomaterials, the ferriteare particularly important for their multiple applications and high-density information storage media, the ferritein the size of the nanometer show many unusual properties. [1,2]. In our research, the MFe_2O_4 binary sentences were studied where M is a bivalent metal. The great development of the past 10 years has contributed to the creation of good technological methods to synthesize these binary sentences. These methods have helped to synthesize good compounds with distinctive properties that meet the needs of modern industries. Many researchers have focused on the synthesis of barium ferrite; It is widely used as a permanent magnet in electronic factories because of its excellent magnetic properties [3]. Several methods have been adopted for obtaining this compound. The most important of these methods are: Sol-Gel, polymerization and other methods. The method of co-sedimentation is one of the most important methods to which scientists have recently turned their attention. This is due to the fact that it is possible to synthesize nanoparticles with nanoscale dimensions and high purity compounds, and to obtain highly homogeneous crystals of small crystalline sizes. In addition to their applications in the field of analytical chemistry and radiation. This method is characterized by the fact that it does not need high temperatures for synthesis, and the factors affecting the structure and properties of the ferriteresulting in this way is the temperature, the degree of PH, and concentration of raw materials used in the preparation process. It also has significant environmental uses and is used to solve water resource problems [4, 5].

Practical Section:
The scientific idea in the research project:
Synthesis of $BaFe_2O_4$ in the method of joint deposition, and studying changes in its structure when treated thermally at different temperatures by XRD spectroscopy and DTA.

Objective of the research project:
Synthesis of the $BaFe_2O_4$ compound in a co-sedimentation method from primary raw materials (barium chloride, tri-iron chloride). These salts are precipitated by a co-sedimentation method in an alkaline medium of sodium hydroxide. And then studying the structural changes in the composition of the barium phosphate formed by changing the temperature of heat treatment, so that we get the compound at the lowest cost of production possible and at low temperatures.

Equipment and tools for synthesis:
The available equipment we used during the laboratory work are: Memmert dryer to dry samples.
Carbolite ashtray reaches up to 1100°C.
Differential thermal analytic device of Chimadzu type.
X-ray diffraction device for powders.

Materials needed for synthesis:
Tri-hydro iron chloride $FeCl_3.6H_2O$ (SR 99%)

Barium anhydrous chloride $BaCl_2$
Sodium hydroxide (NaOH (SCP 96%)
Distilled water for washing and extension.

Sampling Preparation*:*
We prepared the Barium Ferrite compound by following these steps: We first solved a standard amount of $FeCl_3.6H_2O$ iron chloride with a little distilled water then we placed it in a 125 ml volume flask and then completed the volume up to the mark with the distilled water. We prepared the 3M iron chloride solution. In the same way, we prepared the barium chloride solution at a concentration of 1M and then placed the solvents in two identical surfaces. In a later step, we added the two solvents in the two solvents to becher containing sodium hydroxide solution dissolved in water and the concentration at 5M concentration. We added a drop after drop at the same time to obtain a homogeneous solution and we tried as much as possible to add the solvents to sodium hydroxide solution, with heating at about 500℃ and constant stirring by a magnetic drive. After finishing the addition, we continued to stir about 10 minutes to ensure that the mixing was complete and to accelerate the formation of the crystals of the vessel. The color of the resulting vessel was reddish-purple and we did not notice any change during work. Later, we filtered the resulting solution using Bochner funnel in batches. The filtration paper formed a reddish brown and obtained a transparent filtration. We then washed the residue with distilled water several times to make sure it was completely free of chlorine ions, and then repeated the washing with distilled water several times so that the filtration became completely chlorine-free. The washing process took about two days. After finishing the filtration and washing with distilled water, we took the precipitate and placed it in a clean bottle of water. We then placed it in the dryer at 105℃ for about three and a half hours to remove it from the excess water.

Results and discussion:
After we smeared the resulting compound into a fine powder form, we took a small sample of it and pulled it out and drew a spectrum on it. We got diagram (1):

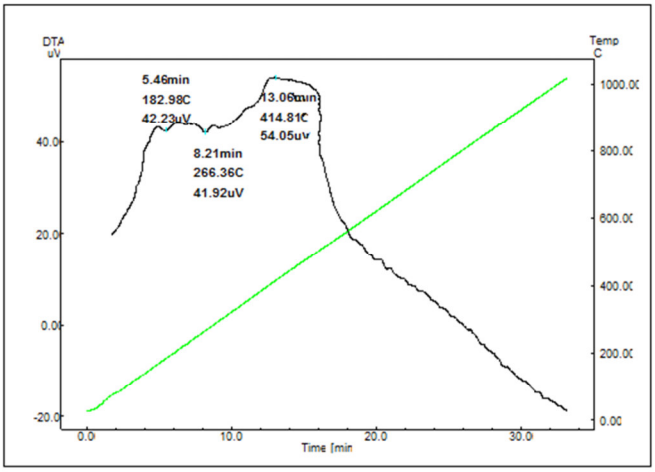

Figure 1: DTA spectra for a sample of barium ferrite with a molar ratio of Zn: Fe = 1: 1

From the DTA spectrum of a barium sample we observed that there were higher-heat (heat-release) and downstream (heat absorbent) absorbers at different temperatures.

Table 1 shows the location and interpretation of these adjuvants

Table (1): Shows the locations of DTA spectrum absorption in a sample of barium ferrite and the causes of their appearance.

Explanation	Type of reaction	DTA Peak^{0}C	Compound
Dehydration	Endo thermic	182.98^{0}C	
Dehydration	Endo thermic	266.36^{0}C	
The beginning of the compound formation $BaFe_2O_4$	Exo thermic	414.81^{0}C	[Ba:Fe=1:1]$BaFe_2O_4$

Study of x-ray diffraction schemes (XRD):
After the drying phase, we moved to a new stage, the burning phase, where we divided the crushed precipitation into five samples, and then placed each sample in a porcelain oven with a heat tolerance up to 1100℃. After finishing, we burned the five samples in an ashtrayfor two hoursat temperatures of 300℃-500℃-700℃-900℃-

1100℃ respectively with slow cooling so as to get clear crystals.

In Diagram 2, we will show the BaO-Fe_2O_3 double-ray diffraction diagrams which was prepared in the co-deposition method at Ba: Fe = 1: 1 at the above temperatures and by the XRD and by using a wave-length (CuKa) = 1,540562^{0}A)

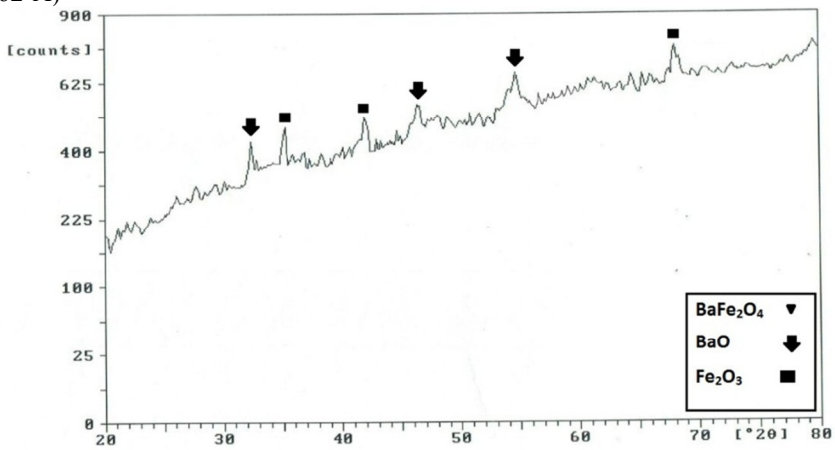

Figure (2-a): X-ray diffraction pattern of a sample of barium ferrite with Ba: Fe = 1: 1 was burned at 3000C for two hours.

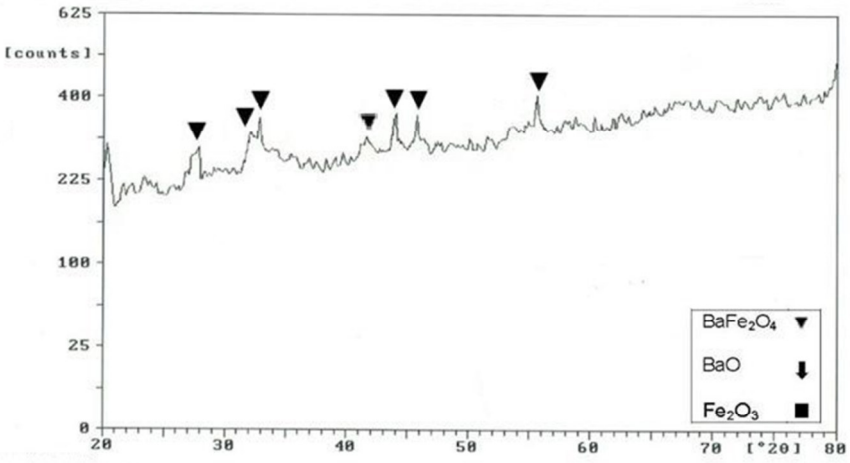

Figure (2-b): X-ray diffraction pattern of a sample of barium ferrite with Ba: Fe = 1: 1 was burned at 500^{0}C for two hours.

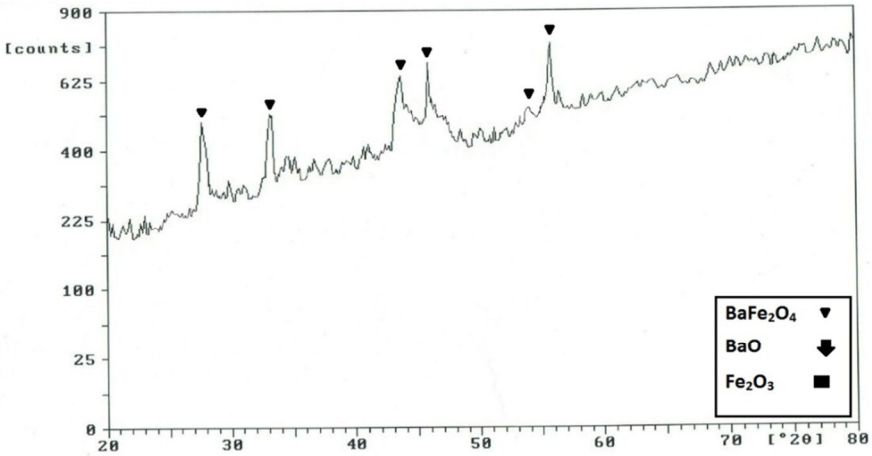

Figure (2-c): X-ray diffraction pattern of a sample of barium ferrite with Ba: Fe = 1: 1 was burned at 700^{0}C for two hours.

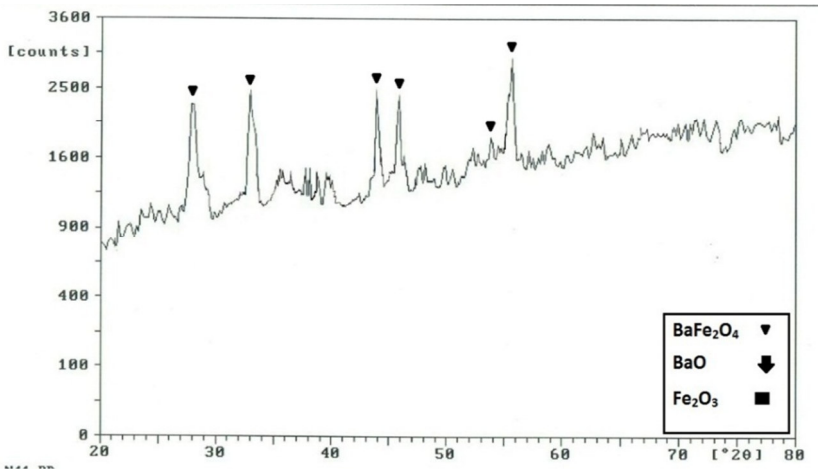

Figure (2-d): X-ray diffraction pattern of a sample of barium ferrite with Ba: Fe = 1: 1 was burned at 900^0C for two hours.

When comparing X-ray diffraction schemes, we found that the $BaFe_2O_4$, which was burned at 300 ° C for two hours without the addition of oxygen water as oxidant, indicates that the above-mentioned compound did not start forming at this grade because no peaks of the compound were indicated. But all the visible peaks and different nodules are due to the reactive primary oxides Fe_2O_3 and BaO, and we confirmed this by comparing our findings with the reference spectra of each of these oxides.

At the 500℃ we notice the disappearance of some peaks of the primary oxides and the emergence of new peaks of the compound $BaFe_2O_4$ formed and confirmed by returning to the reference card of the composite formed, and this indicates that the start of the composition of the $BaFe_2O_4$ compound was at this degree.

In view of the X-ray diffraction pattern of $BaFe_2O_4$ at 700℃, we note that all peaks are due to the formation of the composite. We observe that the follow-up of the heating process to this degree has a significant effect on crystal growth and clarity.

The $BaFe_2O_4$ x-ray diffraction scheme after burning at 900℃ is very similar to the 700℃ diffraction scheme, but the peaks appear sharper and clearer. This indicates that the higher the burning temperature, the better the growth process Crystals and their clarity.

As a result of the comparison of the previous drawings, we found that the 900℃ is the best grade for synthesis where the composition of the vessel has been completed, and the high peaks have emerged with high intensity and great clarity.

CONCLUSIONS

1. We made BaO-Fe_2O_3 in the co-sedimentation method, and we found the optimum degree of synthesis at 900℃, and observed that all the peaks of the primary oxides had disappeared at this degrees.
2. We withdrew the DTA spectra of the $BaFe_2O_4$ compound and the result was identical to the results obtained by XRD.
3 - Increasing the temperature of burning leads to better crystallization process and increases the volume of crystals produced.

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