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A COMPARSION BETWEEN NANO AND MICRO SYNTHESIZED BARIUM COBALT FERRITE TO BE USED AS AN ABSORPTION MATERIAL

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Abstract

Ferrites are ceramic compound with Iron oxide as there principle component. Hexagonal ferrites are commonly used in microwave absorption applications. Hexagonal barium cobalt oxide prepared by traditional ceramic method in both of micro and nanosacles then the characterization of the prepared powders were done by using Scanning Electron Microscopy (SEM) and X-ray diffraction (XRD). From X-ray diffraction pattern results of prepared powders it's found that the nano compound need higher temperature to form desired ferrite (nano $BaCo_2Fe_{12}O_{27}$). The XRD results shows that the nano barium cobalt hexaferrite has more noise peaks. The SEM images shows that the hexagonal shape crystals appears more clearly in micro barium cobalt hexaferrite.

Introduction and related works

Ferrites are ceramic, homogeneous materials composed of various oxides with iron oxide as their main constituent. Ferrites can have several distinct crystal structures and it exhibit ferromagnetism, which can defined as phenomenon by which a

material can exhibit a spontaneous magnetization. It is one of the strongest forms of magnetism [1]. Ferrites include a wide range of materials with various crystal structures, compositions and applications. Commonly used ferrites are primarily classified into three types: spinels, hexagonal ferrites and garnets, according to their primary crystal lattice [2]. Hexagonal ferrites are ferrites with hexagonal shape crystal which have many types depending on its chemicals formula and these types are M, W, Y, Z and X. the most famous type is the M-type hexagonal ferrite with the chemical formula of $BaFe_{12}O_{19}$. The W-type structure consists of one Ba containing layer for every seventh oxygen layer of the spinel structure and is thus closely related to the M structure [3]. Ferrites can be prepared using different methods which are ceramic bulk, co-precipitation and sol-gel. The ceramic method used to prepare the samples that used in this work [4].

The radar absorption materials and structure generally manufactured from ferrites as a raw material because ferrites have the ability to absorb RF and microwaves.Ferrite particles are also used as a component of radar-absorbing materials used in stealth aircrafts and in the expensive absorption tiles lining the rooms used for electromagnetic compatibility measurements [5].JacoboS.E, et.al, (2000) [6], Synthesis ultrafine particles of barium ferrite by chemical coprecipitation method. Gaseous chlorine was bubbled through solution of sodium hydroxide (NaOH), to generate an approximately, the product was characterized by XRD and SEM. ShailajaKulkarni, et.al (2001) [7], highly uniform sub-micrometer size particles of hexagonal strontium ferrite have been synthesized by chemical co precipitation method.Also the material where characterize using XRD and SEM.Nakamuraa T

and Hankuib E, (2007) [8], Polycrystalline Z-type hexagonal ferrites were prepared by a usual ceramic sintering method. First (Ba-Sr,Co)-Z-type hexagonal ferrite ceramics were prepared by the double sintering method. (Ba–Sr,Co)-Z-type hexagonal ferrite ceramics with a small amount of SiO_2 grain boundary component were prepared in a similar way.Kershi R. M and Samir Osman Al-Asbahi,(2013) [9], Series of nanocrystalline hexagonal ferrite ($Ba_{1-z}La_zW$ type where z= 0, 0.01, 0.02,0.03 and 0.04) were prepared by the ceramic technique at presintering 900°C sintering1300°C from barium carbonate and (lanthanum, cobalt, magnesium, and zinc) oxides as raw materials. The X-ray powder diffraction was employed to investigate their microstructure parameters. Characterization was done by XRD and TEM.In the present work Barium CobletHexaferrite was prepared in nano and micro scale, then characterized by X-Ray diffraction technique and Scanning electron microscope, finally compare between them as a radar absorption material.

Synthesis of Barium cobalt ferrite

Barium cobalt ferrite were prepared form the different batches of raw materials shown in Table 1 below.

Table 1: Batches used in preparation of hexaferrites

Weight(gm)	Weight Percentage%	Raw materials	Batch No
16.1621 2.4977	60% 41%	Fe_2O_3 $BaCO_3$	1

2.0321	39%	Co_3O_4	
7.03464 2.02026 1.01603	70% 20% 10%	Nano Ba $Fe_{12}O_{19}$ Nano Fe_2O_3 Nano Co_3O_4	2

The starting material were weighted according to stoichiometric equation depending on the chemical formulas and molar ratios of each compound to prepare each batch as shown below sample of equation balance and molar quantities.

$3BaCO_3+2Co_3O_4+24Fe_2O_3 \rightarrow$
$3BaCo_2Fe_{16}O_{27}+3CO_2+O_2$…… (1)

After weighing the raw material powders, they were mixed in a ball mill using a polypropylene container with the addition of propanol to enhance mixing process by ball mill. The milling and mixing process belong 24 hours to ensure total homogeneity.The resultant powder from mixing was dried in an electrical furnace at 80^{o}C for two hours, then the powder calcined at 1000^{o}C for ten hours.

The calcination process was repeated (two stages calcination) in order to ensure that the reaction was completely happened. The second stage calcination was done at four different temperatures 1000, 1100, 1250 and 1300^{o}C for two hours. Then the prepared powders were characterized using the X-ray diffraction and Scanning Electron Microscopy.

Result and discussion

1. X-ray diffraction:

Figures (1) and (2) shows the XRD pattern for the barium cobalt hexaferrite in nano scale and micro scale respectively.

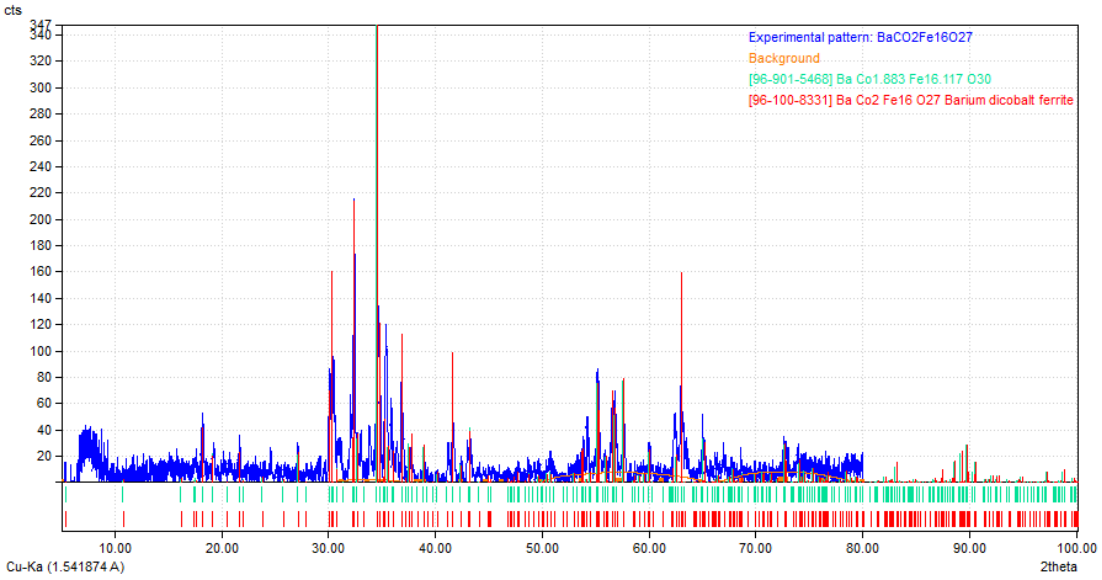


Figure (1): The XRD pattern for prepared nanobarium cobalthexaferritecalcined at1300ºC for two hours period

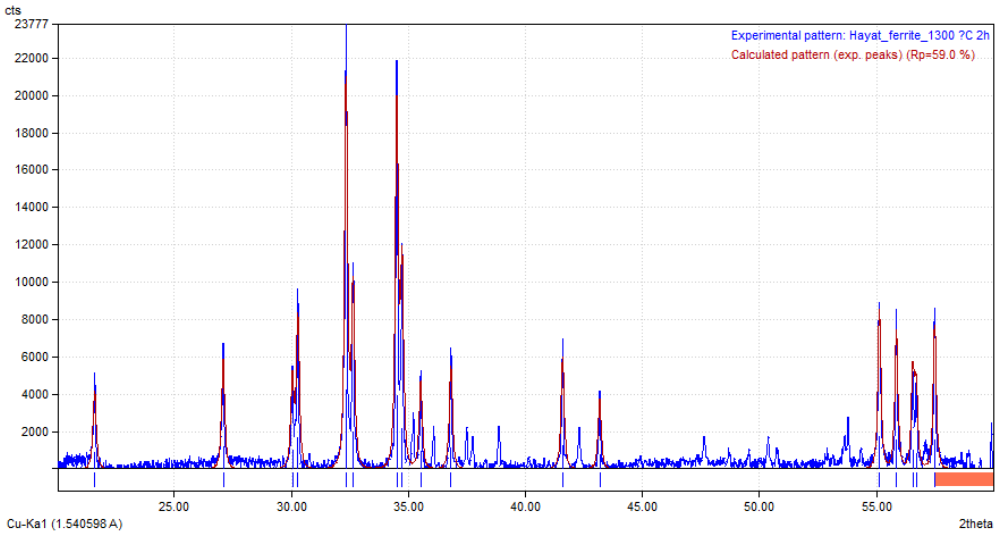
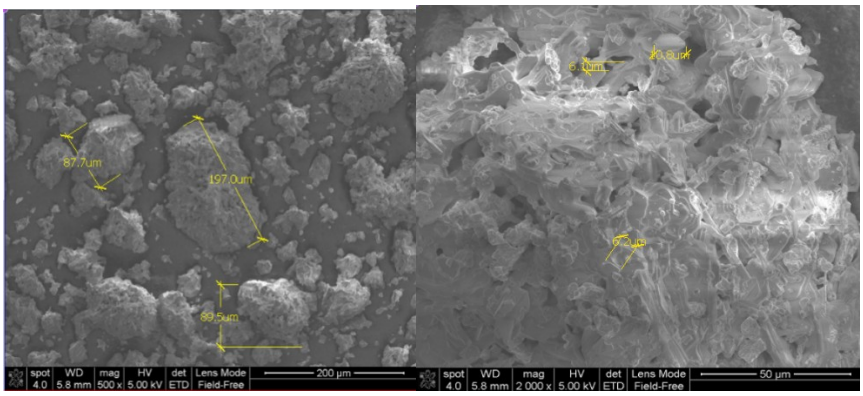


Figure (2): The XRD patternfor prepared barium cobalthexaferritein micro scalecalcinedat1300ºC for two hours period

Comparing between these figures many differences can be detected directly, first of all peaks in the XRD pattern of the nano barium cobalt hexaferrite are sharp and numerous and there are a lot of noise that may come from the nano scale effect on particle shape size and lattice parameter which XRD depend on it, the position of the peaks are the same with some additional peaks that may be caused by the present of impurities or tungsten element that precipitate on the sample surface due to aging of X-ray device.

2. Scanning Electron Microscopy:

The SEM image of barium cobalt hexaferrite are shown in Figure (3). The hexagonal shape of ($BaCo_2$ Fe_{16} O_{27}) molecules clearly appeared in Figure (3), and the impurities also can be notified in the same figure. The crystal growth pattern also appeared in Figure (3). This image can show that the grown process starts from the first crystal and gradually continues to form the other crystals in layered shape.



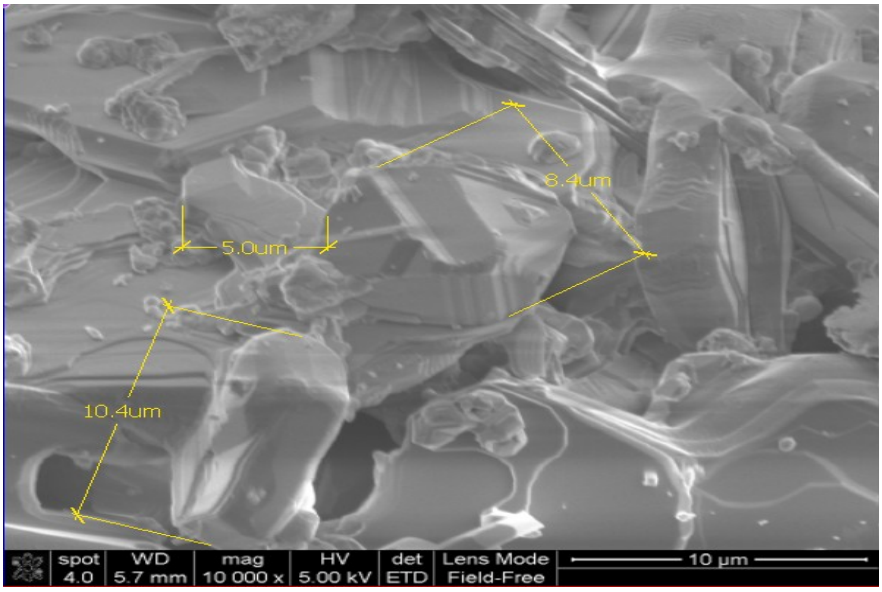
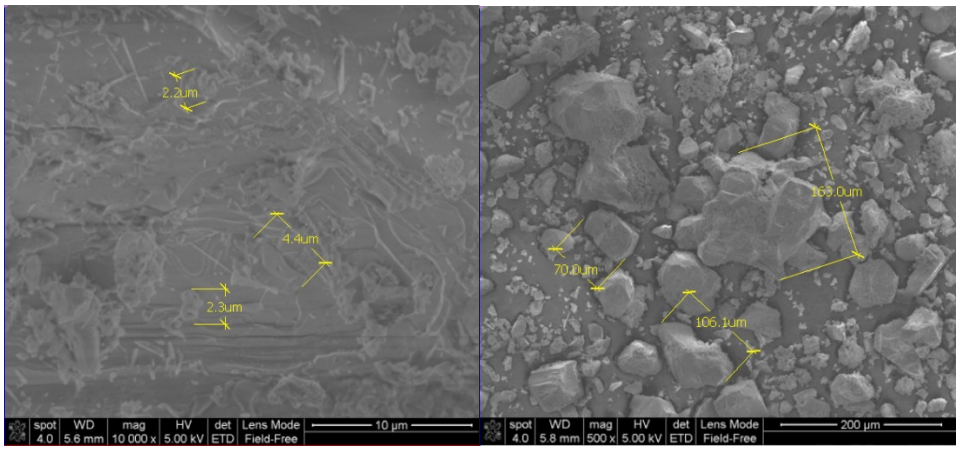
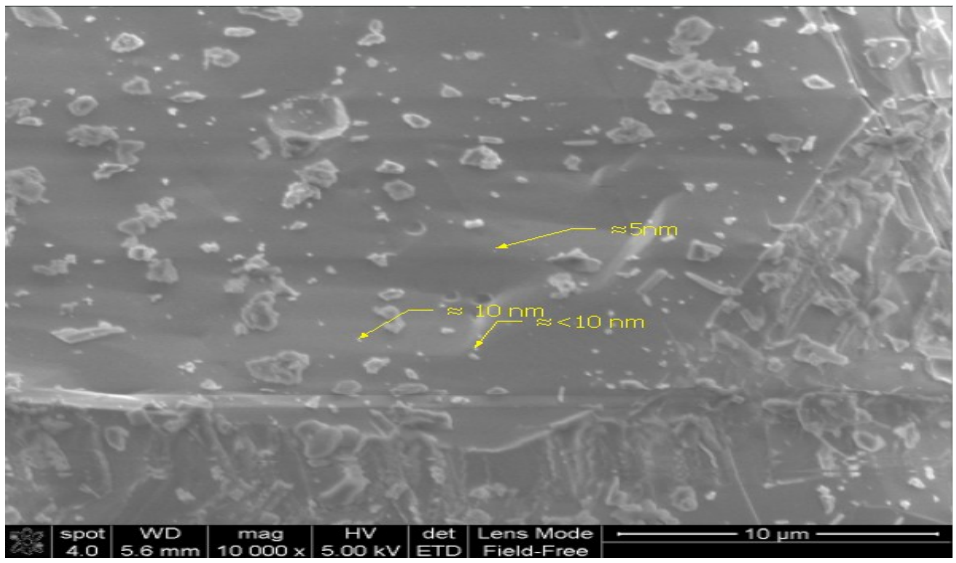


Figure (3): SEM image of Barium cobalt hexaferrite($BaCo_2$ Fe_{16} O_{27})

The SEM image of barium cobalt hex ferrite in nano scale are shown in Figure (4). The hexagonal shape of ($BaCo_2$ Fe_{16} O_{27}) molecules doesn't clearly appear in the Figure (4) because of the fusion (heat and time effects) of the molecules.





Figure(4): SEM images of barium cobalt hexaferrite $BaCo_2Fe_{12}O_{27}$ in nano scale

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Conclusion

For Barium Cobalt Ferrite in micro and nano scale and from the XRD data it’s found that the nano Barium Cobalt Ferrite has more

noise than the micro Barium Cobalt Ferrite also the appearance of nano Barium Cobalt Ferrite is more bright than the micro one.

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