Synthesis and Characterization of Barium Hexaferrite by Solid State Reaction

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Abstract

Synthesis and characterization of barium hexaferite by Solid state reaction method has been used to grow crystalline barium hexaferite($BaFe_{12}O_{19}$) by using the temperature of 1000^oC and 1200^oC to obtain the required results as using the duration of four(4)hours respectively at a pressure of twenty (20) ton hydraulic machine to prepare the pellets having a diameter of five(5)mm to eight(8)mm and its thickness is1.5mm to 02mm,it has been used for the structural study of XRD, SEM, EDX, and B-H curve to perform, for XRD measurement the structure of the material are formed to be hexaferite.

Keywords. XRD (X-rays diffraction), SEM (Scanning electron microscopy), EDX, B-H curve (magnetic properties), Comparison, Calculations on peletting size and diameter.

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INTRODUCTION

Hexagonal barium hexaferrite ($BaFe_{12}O_{19}$) is widely used for various important electronic applications such as permanent magnets, particulate media ferromagnetic recording and microwave devices (Pfeiffer et al., 1993, Smit et al., 1961, Buchner et al., 1989)."we can use the barium oxide and hard magnetic materials to find out the stiochiometry Bao because the mentioned materials are based on iron oxide which cannot easily be replaced by one an other as well as by any other magnet". (Qiu and Gu, 2005, Bowicz et al., 2007, Dobrzaiski et al., 2006, Drak and Dobrzaiski, 2007) Many methods of synthesis have been developed to obtain a low production cost of powder particles of barium ferrite. There are earth magnets that are used where weight and size are very important from the cost and performance point of view (Makled et al., 2005, Martienssen and Warlimont, 2005). The hard magnetic barium hexaferrite has been widely used as a permanent magnet because of its fairly large magneto crystalline anisotropy and high curie temperature, together with its relatively large saturation magnetization, excellent chemical stability, and corrosion resistively. (Sankaranarayanan et al., 2000) The application of hexagonal ferrites in the magnetic media industry requires materials with strict control of homogeneity, morphology and magnetic properties resulting from preparation technology and heat treatments. Hexagonal ferrites show good chemical and thermal stability which would result in longer storage life of the media . However all these methods require two basic production operations firstly mixing of initial components either mechanically or chemically and secondly a subsequent heat treatment of the obtained mixture, the temperature usually ranges from 700^oC to 1400^oC. Because of the annealing at high temperatures the grain size of the barium ferrite is usually larger than 50nm, which limits the possibilities of obtaining ultra fine particles for the desired applications, especially basic research. On the other hand it is reported that the saturation magnetization for magnetic materials decreases with decreasing particle size .

MATERIALS AND METHODS

In this section we have used the two materials called $BaCo_3$ & Fe_2O_3 in a pure powder form to achieve barium hexa ferrite which has a chemical formula $BaF_{12}O_{19}$.The formula obtained by milling & heating process at 1000°C and 1200°C. For weight we have used BUITEMS university chemistry lab (Takatu campus)for the sake of exact ratio we have used four (4) digits sensitive weight balance after ten decimal. The ratio is given bellow Atomic weight of different element.

Fe=55.8457amu.

Ba=137.327amu.

O=15.9994amu.

So using the above values we have achieved the exact formula weight of $BaO_6Fe_2O_3$ which is 1111.3264.The value of $6Fe_2O_3$ is 958.1376gm while 197.3359gm of $BaCo_3$ produces BaO of 153.3264.The percentage of Oxygen is 82.9930 % and Barrium is 17.0069% now adding the values Fe_2O_3 and $BaCo_3$ which are 958.1376 and 197.3359 respectively we get the result 1155.4735 again adding Fe_2O_3, BaCo3 and BaO values we achieved the 6.8974gm.The actual value obtained by raw material is 53.2608gm.

Measurement and analysis.

The work we have started from the mixing of the barium carbonate ($BaCo_3$), and Iron oxide (FeO_2) at Islamia University of Bahawalpur where we have tried our best to mix it as its highest approach after mixing them we went to Bahauddin Zakaria University Multan for pressing and preparing pellets using 20 ton hydraulic pellets machine at high pressure to obtain the best results from these machines. After the preparation of these items we took it back to BUITEMS in chemistry department to put these pellets in high temperature accumulated machine for the temperature of 1000°C and 1200°C. The samples which we were prepared here sent to KRL institute Islamabad to be examined for SEM XRD EDX and B-H curve results at 1000 °C and 1200 °C.

Mixing the composition of material by ball mill method ($BaFe_{12}O_{19}$).

The process we have done by using the ball mill method from Islamia University Bahawalpur by mixing the Fe_2O_3+$BaCo_3$ powder to obtain $BaFe_{12}O_{19}$.

PELLETING PROCESS.

For pellets preparation we have also approached to Islamia University Bahawalpur. There we have used 20 ton of hydraulic machine for the preparation of pellets.

HEAT ANNEALING.

Heat annealing is the process where we have used a high temperature about 1000°C, 1200°C with respect to using of the time 2 hour to 4 hour by obtaining the proper results of heat annealing method.

RESULTS

1. XRD at 1000°C

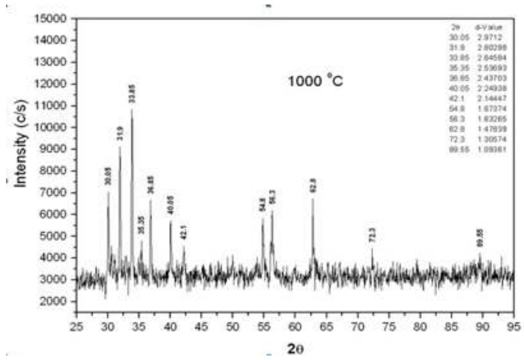

Figure 1: XRD at 1000°C

2. SEM at 1000°C.

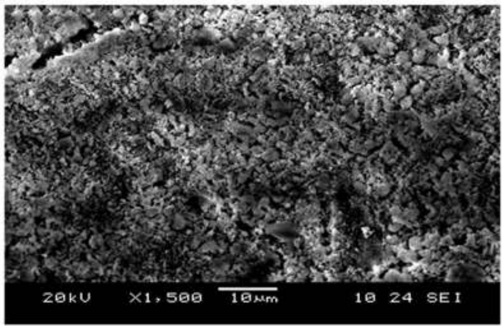

Figure 2: SEM at 1000°C

3. SEM at 1000⁰C

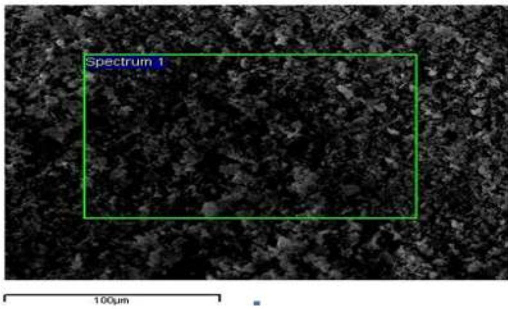

Figure 3: EDX at 1000°C

4. B-H Curve at 1000°C

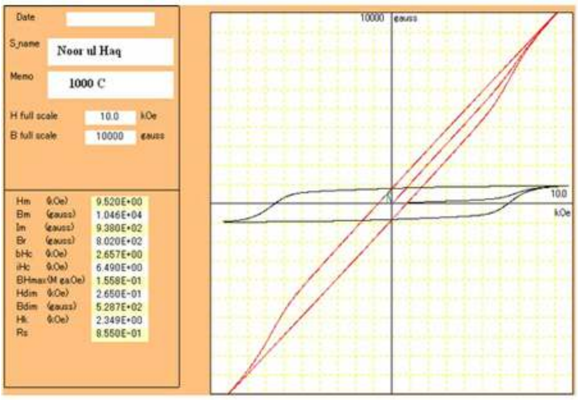

Figure 4: B-H Curve at 1000°C

Table 1. EDX at 1000°C

Spectrum Label	O	Si	S	Fe	Ba	Total
Spectrum 1	30.93	21.6	34.49	30.92	12.03	100.00
Max.	30.93	21.6	34.49	30.92	12.03	100.00
Min.	30.93	21.6	34.49	30.92	12.03	100.00

5. XRD at 1200°C

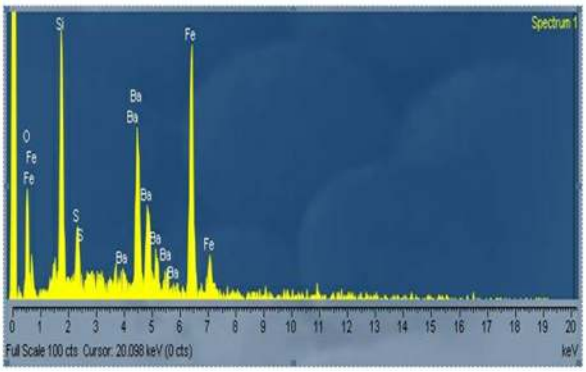

Figure 3.1: EDX at 1000F°C

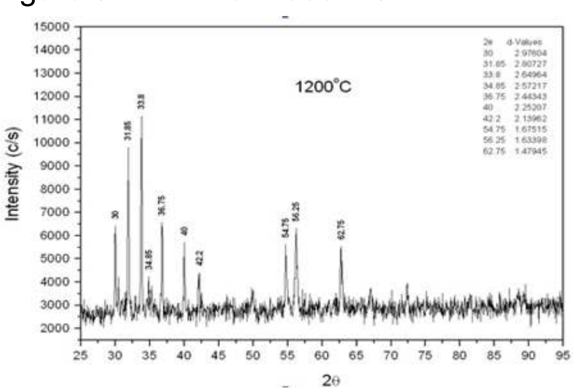

Figure 5: XRD at 1200°C

6 SEM at 1200°C

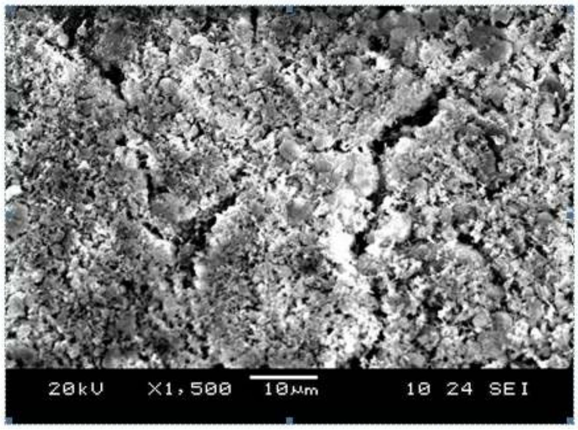

Figure 6: SEM at 1200°C

7. SEM at 1200°C

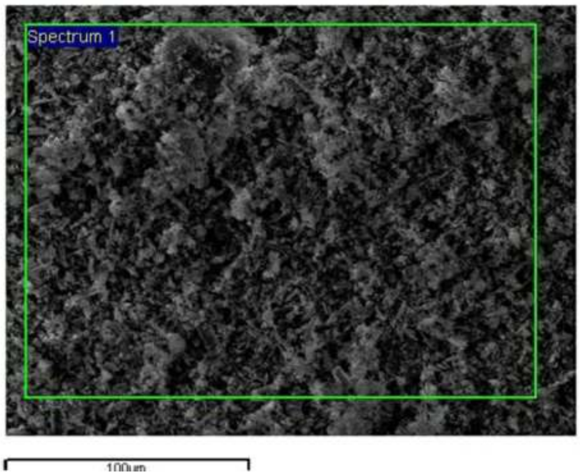

Figure 7: EDX at 1200°C

8. **B-H Curve at 1200**°C

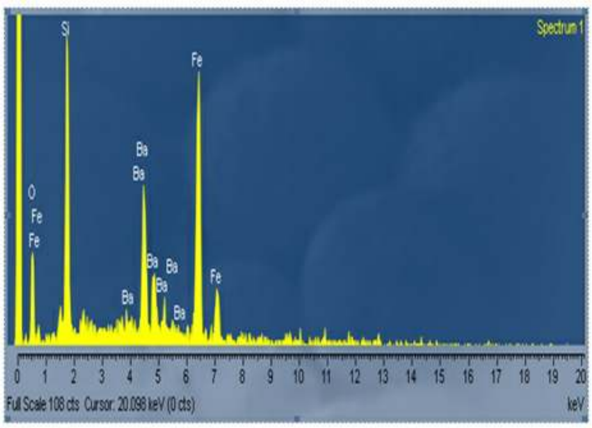

Figure 7: EDX at 1200°C

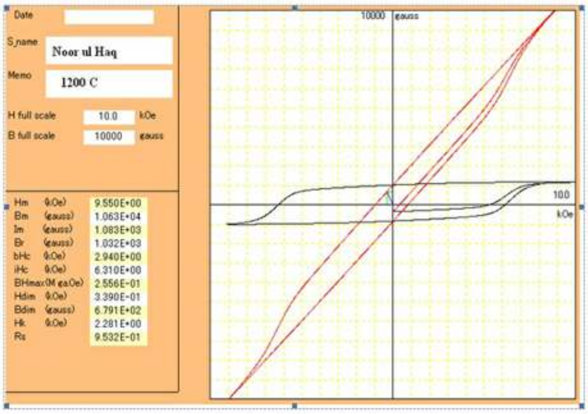

Figure 8: B-H curve at 1200°C

Table 2. EDX at 1200°C

Spectrum Label	O	Si	Fe	Ba	Total
Spectrum 1	30.32	25.67	34.4	59.56	100.00
Max.	30.32	25.67	34.4	59.56	100.00
Min.	30.32	25.67	34.4	59.56	100.00

CONCLUSION.

By the study of synthesis and crystallization of barium hexa ferrite ($BaFe_{12}O_{19}$) by solid state reaction using the mythology of XRD, SEM, EDX, and B-H curve, it has been found that the growth of crystalline by solid state reaction, whereas the microscopic structure of material is by SEM method and the change in shape of alloy was also observed which shows the presence of oxygen too. During the EDX process the Ba, Fe, O, Si and S has been found in figure 1000°C while in 1200°C figure there is the absence of sulphar (S) which also has not been shown in table too so the changes in the magnetic field are also observed at a temperature of 1000°C & 1200°C respectively with the intensity of 11000 & 11500 by using the annealing method at the required temperature. We have found the change in the morphology of the material as well in the change of the curve of the peaks as depicted in figures. Finally the weight percentage of material has been observed by EDX method so it is stated that the material is cubical by structure.

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