Synthesis And Characterization Of Strontium Hexaferrite By Solid State Reaction

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Abstract

The characterization and magnetic structural properties of strontium hexaferrite ($SrFe_{12}O_{19}$) has been prepared by solid state reaction method. The Pellets melted at different temperatures 1000˚C for 2 hour & 1200˚C for 3 hour. For structural study, X-ray diffraction (XRD), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS or EDX) and magnetic properties were performed. We observed hexagonal crystal structure of strontium hexaferrites refined from X-ray single crystal data and also observed peak value of angle 2θ is 31.9 at 11500 intensity for 1000˚C and 31.85 at 12500 intensity for 1200˚C. By using SEM technique we observed the topography and morphology of the samples. The B-H curve for the strontium hexaferrites samples was observed at different parameter such as saturation magnetization, remanence and coercivity, under different temperatures.

Keywords: Solid state reaction, X-rays diffraction, Scanning electron microscopy, Energy dispersive X-ray, B-H curve and Comparison.

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INTRODUCTION

Strontium hexaferrites has been widely used as a permanent magnet because of its large magneto crystalline anisotropy and high Curie temperature, with its relatively large saturation magnetization, reduce the resistivity, excellent chemical and thermal stability (Shan et al,.2005). Strontium hexaferrites is permanent magnet and its formula is ($MFe_{12}O_{19}$), where M stands for Sr, Ba, and Pb etc. Its crystal structure is hexagonal magneto sometimes called M-type hexaferrite. The M-type hexaferrite crystallizes in a hexagonal structure with 64 ions per unit cell on 11 different symmetry sites. The unit cell contains 38-oxygen ions, 24-ferric ions and 2 M ions (Joyce, 2007 and Pual and Millan,2000). Ferrites have been found to be the best magnetic materials. It's widely used in many applications due to good combination of magnetic and electrical properties. Ferrite is a class of ceramic materials with useful electromagnetic properties (Maqsood et al,.2011). Strontium hexaferrite is a dielectric material. The high electrical resistivity of hexaferrites coupled with their low magnetic losses is critical in maintaining low incorporation loss in microwave devices (Pillai, 2003).

MATERIALS AND METHODS

Chemical Compositions of Material

Atomic weight of strontium hexaferrite material is

Fe = 55.8457 amu.

Sr = 87.6200 amu.

O = 15.9994 amu.

The materials have been found in a nano crystal powder form, having a percentage of purity is 99.99%. These materials are $SrCO_3$ and Fe_2O_3. We have been preparing strontium hexaferrites SrO 6(Fe2O3), and measured by highly accreted sensitive balance.

Mixing of Compounds

Mixing of materials is an important step in the preparation of strontium hexaferrite. These materials were mixed by using the instrument called Ball milling.

Pelleting

Hydraulic pressing machine used for 10 to 20 Ton. Under such a pressure the required shape and size have been achieved.

Heat Annealing

In this process annealed the sample of pellets at different temperature at different timing by using the Crucibles. The pellets have been annealed at 1000˚C for 2hour and 1200˚C for 3hours respectively. Samples which have been prepared and then describe the result of XRD, SEM, EDX and B-H curve.

RESULTS & DISCUSSION

The linear thermal coefficient for strontium hexaferrite was found to be 14 x 10^6 and 10 x 10^6 K^{-1} for the sample placed parallel and perpendicular to the coaxial-axis, respectively. The value of thermal conductivity is 2.69 $Wm^{-1}K^{-1}$ and heat capacity per unit volume of strontium hexaferrite at room temperature is 2.73 $MJm^{-3}K^{-1}$ (Hberey and Cockel, 2003). The hardness value of strontium hexaferrite is 8.6 k Nmm^{-2} (Veldkamp et al, 1976). And flexible strength is 86.3 ± 7.8 Nmm^{-2} (Kools,1973).

X-ray Diffraction (XRD) image at 1000˚C

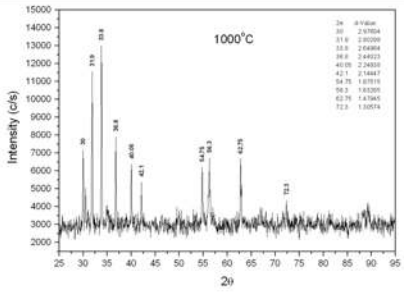

Table1: 2θ values at 1000C

2θ	d-Value
30	2.97604
31.9	2.80298
33.8	2.64964
36.8	2.44023
40.05	2.24938
42.10	2.14447
54.75	1.67515
56.30	1.63265
62.75	1.47945
72.30	1.30574

Figure 1: XRD is used to study the crystal structure of Strontium hexaferrite, which is prepared at 1000˚C for 2 hours.

Scanning Electron Microscopy (SEM) image at 1000˚C

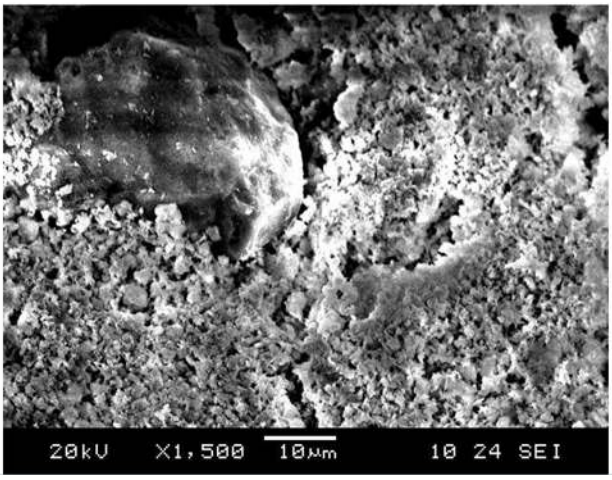

Figure 2: SEM micrograph image of Strontium hexaferrite at 1000˚C temperature.

Hysteresis curve (B-H curve) image at 1000˚C

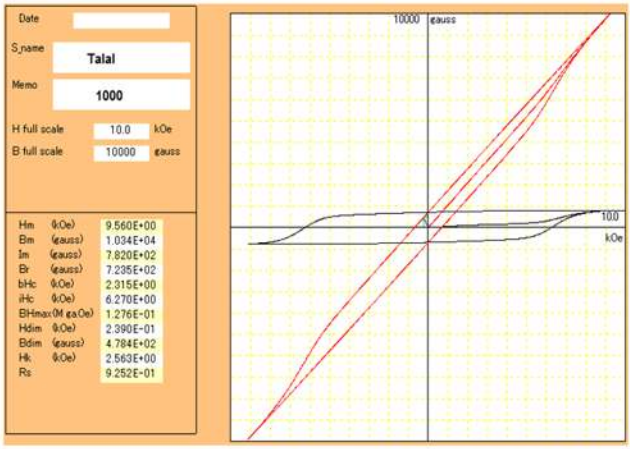

Figure 3: Magnetic Hysteresis curve of the Strontium hexaferrites at 1000˚C temperature.

X-ray diffraction (XRD) image at 1200˚C

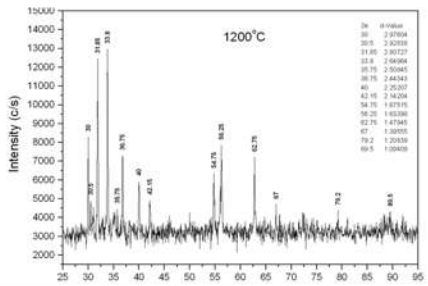

Table1: 2θ values at 1200˚C

2θ	d-Value
30	2.97604
30.50	2.92838
31.85	2.80727
33.80	2.64964
35.75	2.50945
36.75	2.44343
40	2.25207
42.15	2.14204
54.75	1.67515
56.25	1.63398
62.75	1.47945
67	1.39555
79.20	1.20839
89.5	1.09409

Figure 4: XRD is used to study the crystal structure of Strontium hexaferrite, which is prepared at 1200˚C for 3 hours.

Scanning Electron Microscopy (SEM) image at 1200˚C

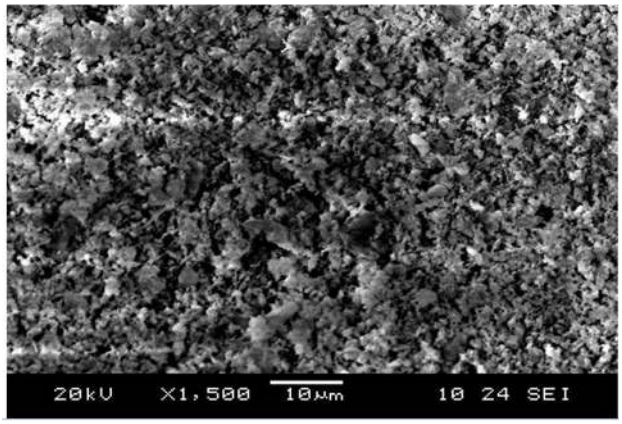

Figure 5: SEM micrograph image of Strontium hexaferrite at 1200˚C temperature

Hysteresis curve (B-H curve) image at 1200˚C

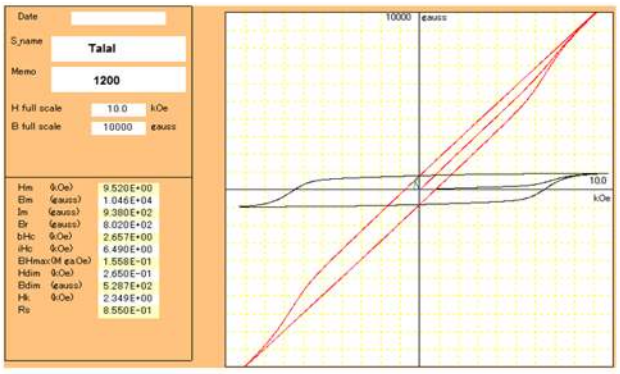

Figure 6: Magnetic Hysteresis curve of the Strontium hexaferrites at 1200˚C temperature.

CONCLUSION

In this research paper we have investigated the characteristic and magnetic structural properties of Strontium hexaferrite $SrFe_{12}O_{19}$ using X-ray diffraction 'XRD', scanning electron microscopy 'SEM', and B-H curves Crystalline have been grown by solid state reaction method. The pallets were melted at different temperatures. Hexagonal structures have been observed at room temperature and also provide the information on the structures, phases and other structural parameters such as lattice constant, cell volume, crystallite size and X-ray density. By using scanning electron microscopy I have observed the microscopic structure of strontium hexaferrites compound at different temperature. I have observed fracture, dust particles in the alloy and also observed the presence of oxygen. The variation of saturation magnetization, remanence and connectivity properties of B-H curves have been observed under different temperature. The hysteresis loop shows the relationship between the induced magnetic flux density "B" and the magnetizing force "H". Hard magnetic materials have rectangular hysteresis loop and has the wide hysteresis loop due to strong magnetization.

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