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Effect of Ratio in Ammonium Nitrate on the Structural, Microstructural, Magnetic, and AC Conductivity Properties of $BaFe_{12}O_{19}$

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Abstract: This paper investigates the effect of the ratio of ammonium nitrate (AN) on the structural, microstructural, magnetic, and alternating current (AC) conductivity properties of barium hexaferrite ($BaFe_{12}O_{19}$). The $BaFe_{12}O_{19}$ were prepared by using the salt melt method. The samples were synthesized using different powder-to-salt weight ratio variations (1:3, 1:4, 1:5, 1:6 and 1:7) of $BaCO_3$ + Fe_2O_3 and ammonium nitrate salt. The NH_4NO_3 was melted on a hot plate at 170 °C. A mixture of $BaCO_3$ and Fe_2O_3 were added into the NH_4NO_3 melt solution and stirred for several hours using a magnetic stirrer under a controlled temperature of 170 °C. The heating temperature was then increased up to 260 °C for 24 hr to produce an ash powder. The x-ray diffraction (XRD) results show the intense peak of $BaFe_{12}O_{19}$ for all the samples and the presence of a small amount of the impurity Fe_2O_3 in the samples, at a ratio of 1:5 and 1:6. From the Fourier transform infra-red (FTIR) spectra, the band appears at 542.71 cm^{-1} and 432.48 cm^{-1}, which corresponding to metal–oxygen bending and the vibration of the octahedral sites of $BaFe_{12}O_{19}$. The field emission scanning electron microscope (FESEM) images show that the grains of the samples appear to stick each other and agglomerate at different masses throughout the image with the grain size 5.26, 5.88, 6.14, 6.22, and 6.18 μm for the ratios 1:3, 1:4, 1:5, 1:6, and 1:7 respectively. From the vibrating sample magnetometer (VSM) analysis, the magnetic properties of the sample ratio at 1:3 show the highest value of coercivity H_c of 1317 Oe, a saturation magnetization M_s of 91 emu/g, and a remnant M_r of 44 emu/g, respectively. As the temperature rises, the AC conductivity is increases with an increase in frequency.

Keywords: Barium ferrites ($BaFe_{12}O_{19}$; BF); steel wastes; ammonium nitrate salt melts method (ANSM); microstructures; magnetic properties; AC conductivity

1. Introduction

Barium hexaferrites ($BaFe_{12}O_{19}$) have a hexagonal magnetoplumbite structure [1] and they are considered to be unique materials. They are hexagonal, with space group $P6_3/mmc$ (No. 194) with lattice dimensions a = b ≈ 5.90 Å, c ≈ 23.30 Å containing 38 oxygen ions, 24 iron ions, and two barium ions [2,3]. This is due to its interesting properties, such as high chemical stability [4], large magnetocrystalline anisotropy [1], large saturation magnetization [5], high coercivity [1], and