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Magnetic Properties of Sr-M Ferrite Fine Particles

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Abstract - Single phase Sr-M ferrite fine particles were prepared by the chemical coprecipitation and subsequent heat-treatment methods. The chemical reagents used for an experiment are $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ and $\text{Sr}(\text{NO}_3)_2$. A solution containing Fe^{3+} and Sr^{2+} in the molar ratio ($\text{Fe}^{3+}/\text{Sr}^{2+} = n$) 7.0~11.0 was poured into a solution of NaOH (pH = 10~13). Aqueous suspensions containing the precipitated products were boiled for 2hs, and they were carefully washed, filtrated and dried at 80 °C for 8hs. The obtained fine particles were heated 800 to 1100 °C for 2hs in air to get single phase Sr-M ferrite fine particles. The optimum preparing condition of single phase Sr-M ferrite fine particles are as follows : reagents : $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ and $\text{Sr}(\text{NO}_3)_2$; the molar ratio: $\text{Fe}^{3+}/\text{Sr}^{2+} = 8$; pH = 13; the heat-treatment condition : 900 °C x 2hs in air. The magnetic and physical properties are $\sigma_s = 87.0 \times 10^{-6} \text{ Wb} \cdot \text{m/kg}$ (69.2 emu/g), $H_J = 501.3 \text{ kA/m}$ (6.3 kOe), $H_{A_{\text{ave}}} = 945.4 \text{ kA/m}$ (11.9 kOe), $T_c = 462 \text{ °C}$, the lattice constants $a = 5.882 \times 10^{-10} \text{ m}$, $c = 23.05 \times 10^{-10} \text{ m}$, $c/a = 3.919$, the activation energy = 182.0 kJ/mol (43.5 kcal/mol) and the average particle size = 0.2 μm .

1. INTRODUCTION

Many reports on various preparation methods of $\text{BaO} \cdot 6\text{Fe}_2\text{O}_3$ and $\text{SrO} \cdot 6\text{Fe}_2\text{O}_3$ ferrite fine particles have been presented[1]~[7]. In these methods, $\text{BaO} \cdot 6\text{Fe}_2\text{O}_3$ ferrite fine particles prepared by the chemical coprecipitation and subsequent heat-treatment methods are gained the single phase and the high coercivity and magnetization. However $\text{SrO} \cdot 6\text{Fe}_2\text{O}_3$ ferrite fine particles prepared by this method are not gained the single phase (finally, to remove the other phase need to acid-treatment[6]), and their magnetization is low.

This experiment carried out to investigate the single phase Sr-M ferrite fine particles prepared by the chemical coprecipitation and subsequent heat-treatment methods.

2. EXPERIMENTAL PROCEDURE

The chemical reagents used for an experiment are $\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$, $\text{Sr}(\text{NO}_3)_2$, $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ and $\text{Fe}(\text{NO}_3)_3 \cdot 9\text{H}_2\text{O}$. A solution containing Fe^{3+} and Sr^{2+} in the molar ratio ($\text{Fe}^{3+}/\text{Sr}^{2+} = n$) 7.0~12.0 was poured into a solution of NaOH (pH = 10~13). Aqueous suspensions containing the precipitated products were boiled for 2hs, and they were carefully washed, filtrated and dried at 80 °C for 8hs. And in the molar ratio $n=10\sim12$, treatment after coprecipitation was tried three process (1. boiling only, 2. boiling and washing, and 3. without boiling and washing). The obtained fine particles were heated 800 to 1100 °C for 2hs in air to get single phase Sr-M ferrite fine particles. The magnetic properties, the distribution of anisotropy field and Curie temperature of these isotropic particles were measured by a vibrating sample magnetometer. The saturation magnetization (σ_s) was measured by applying a magnetic field of 1600 kA/m using by a VSM, and was calculated by $1/H^2$. The crystal structural analysis was carried out by X-ray diffraction patterns recorded using $\text{FeK}\alpha$ radiation, while the particle size was examined by SEM and TEM. The formation of Sr-M ferrite and the activation energy were examined by DTA and TG scans for the coprecipitated particles with various heating rates between 2 °C/min and 20 °C/min. For comparison BaM and SrM ferrite fine particles, BaM ferrite fine particles were prepared by the chemical coprecipitation and subsequent heat-treatment methods using reagent of $\text{Ba}(\text{NO}_3)_2$ and $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ in molar ratio $n=10.5$.

3. RESULTS AND DISCUSSION

The preparation of Sr-M ferrite fine particles using with various combinations of reagents was attempted. As a result, good magnetic properties of Sr-M ferrite fine particles was obtained using with the combination of $\text{FeCl}_3 \cdot 6\text{H}_2\text{O}$ and $\text{Sr}(\text{NO}_3)_2$ reagents.