A study of coercivity of Co-Ni spinel ferrites at successive stages of synthesis

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Magnetic nanoparticles with a distinctive synthesis route possess tremendous potential in technological applications for high-density information storage[1]. High-quality spinel cobalt-nickel ferrite nanoparticles were synthesized by undergoing a succession of synthesis routes comprised of chemical co-precipitation, hydrothermal treatment, and etching in hydrochloric acid. The samples produced by chemical co-precipitation and then hydrothermal treatment are denoted by AP and HT respectively, while the samples produced as a result of etching after hydrothermal treatment are indicated by ET2 (HCl solution 2.0 mole/L), ET4 (4.0 mole/L), and ET6 (6.0 mole/L). The crystal structure and size were determined by means of transmission electron microscopy and X-ray diffraction. Magnetization and demagnetization were measured by using a vibrating sample magnetometer. It was found that the specific saturation magnetization and coercivities change with the samples, reaching maximum of respectively 61 emu/g for the ET2 sample and 6562 kA/m for the ET4 sample (Table 1).

The HT sample showed a magnetization and coercivity of 52 emu/g and 4519 kA/m respectively, so the etching process produces a considerable effect on the coercive force (see Fig. 1). The effective magnetic anisotropy constants of these samples were calculated by using the law of approach to saturation.

Mössbauer spectroscopic experiments at room temperature and 4.2 K with no applied magnetic field and at room temperature with an application of external magnetic field (5 T) were also carried out on both the HT and ET2 samples[2]. It was found that etching leads to a significant variation of the Fe3+ ion distribution in the tetrahedral (A sites) and octahedral (B sites) sites of the Co-Ni spinel ferrite (Table 2). The cation distribution thus makes it evident that lattice defects are probably present and may be the principal factor in increasing coercivity.

References:

1) V. Dupuis *et al.*, MRS Online Proceedings Library Archive (2014) 1708.
2) W. Keune, Hyperfine Interactions 204 (2012), 13-45B.

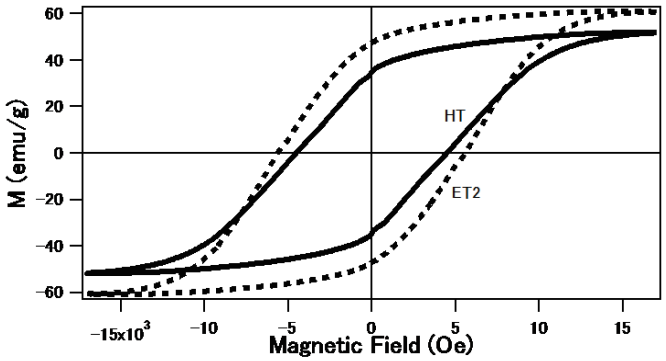

Fig. 1 M-H curve of HT and ET2 samples measured at 300 K.

Table 1: Saturation magnetization (M_s), squareness ratio (SR) and coercivity (H_c) at room temperature

Samples	M_s (emu/g)	SR	Coercivity (Oe)
AP	21.5	0.51	4604
HT	52	0.67	4519
ET2	61	0.78	5605
ET3	60.4	0.77	6281
ET4	60.5	0.77	6562
ET6	59.9	0.70	6423

Table 2: Relative area occupied by Fe^{+3} ion in HT and ET2 samples

Area (%)		
Sample	A site	B site
HT	71	29
ET2	63	37