Applied-Field Dependent Hyperfine Structure and Magnetic Properties of $Ni_{0.8-x}Cu_xZn_{0.2}Fe_2O_4$

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The crystal structure of $Ni_{0.8-x}Cu_xZn_{0.2}Fe_2O_4$ ($x = 0.2$, **0.4, 0.6**) sample is determined to be cubic spinel with space group Fd-3 m by Rietveld refinement. The lattice constant a_0 increased linearly with the Cu concentration from $x = 0.2$ to **0.6**. With increasing Cu concentration, the saturation magnetization and coercivity decreased from 101.3 emu/g, 112 Oe to 88.7 emu/g, 83 Oe, respectively, at **4.2 K**. Ni and Cu ions in NiCuZn ferrite prefer octahedral sites (B) and Zn ions prefer tetrahedral sites (A). Based on the distribution probability, we have analyzed Mössbauer spectra measured at 4.2 K as 5 sets with six-lines. Hyperfine fields at A and B sites at 4.2 K with zero magnetic field were $H_{hf}(A) = 500$ kOe, and $H_{hf}(B_0) = 545$ kOe, $H_{hf}(B_1) = 525$ kOe, $H_{hf}(B_2) = 516$ kOe, $H_{hf}(B_3) = 483$ kOe, for $x = 0.6$. Applied-field Mössbauer spectra of $Ni_{0.8-x}Cu_xZn_{0.2}Fe_2O_4$ were measured parallel to the γ-ray direction under **5 T at 4.2 K**. Hyperfine field $H_{hf}(A)$ at A site under 5 T was **516 kOe**, larger than that under zero applied-field, and at B site the average value of hyperfine field $\langle H_{hf}(B) \rangle$ was **440 kOe**, smaller than $\langle H_{hf}(B) \rangle = 517$ kOe under zero applied-field, for $x = 0.6$. Then the hyperfine field at A and B sites decreased with increasing Cu content $x = 0.2$ to **0.6**. Also, we noticed that the second and fifth absorption lines of Mössbauer spectra completely disappeared above **1 T**, indicating that the spins of Fe ions at A and B sites were collinear to the applied-field. The Fe valence state was determined to be ferric from the isomer shift values.

Index Terms—Applied-field Mössbauer spectroscopy, distribution probability, NiCuZn ferrite, spin collinear.