Investigation of site distribution on iron in spinel $FeGa_2O_4$ with Mössbauer spectroscopy

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1. INTRODUCTION

Spinel structures AB_2O_4(A,B=transitionmetal) have attracted much attention, because of the unprecedented magnetic properties such as spin-glass, colossal magnetoresistance(CMR) effect, metal-insulator transition at low temperature.[1,2] Recently, it has been reported that the cubic spinel $FeGa_2O_4$ is antiferromagnet with spin glass behavior with disordered spin, atomic short-range-order, incommensurated spin structure at low temperature. Furthermore, $FeGa_2O_4$ is concurrent with clusters and ferromagnetic spin-ordering below T_f=12K, as superparamagnetic behavior[3,4]. Especially, J.Ghose[5,6] has shown that $FeGa_2O_4$ is purely inverse $[Fe_{0.05}Ga_{0.95}]^A[Fe_{0.95}Ga_{1.05}]^BO_4$, whereas $FeGa_2O_4$ is normal spinel$[Fe]^A[Ga_2]^BO_4$ from Mössbauer measurements[5]. Then, microscopic magnetic properties are as yet unsolved problems with dependent site distribution of iron. In this paper, we have researched magnetic properties of $FeGa_2O_4$, arising from magnetic structure-transition, spin-relocation, and site distribution of iron on dependent temperature.

2 EXPERIMENT PROCEDURES

Synthesis of $FeGa_2O_4$ sample was done by a standard solid-state reaction method in evacuated 10^{-7}torr quartz ampoules. In order to obtain homogeneous materials, it was necessary to grind the mixed powders of Fe (99.99 %), Fe_2O_3(99.995%),andGa_2O_3(99.99%) and press the powder into pellet before annealing process in evacuated quartz ampoules. A single phase of $FeGa_2O_4$ was obtained by annealing at 1000°C with nitrogen gas in evacuated quartz ampoules for 4 days. The crystal structure of sample of $FeGa_2O_4$ was analyzed by using Philips X'Pert diffractometer with Cu *Ka* radiation source. Their magnetic properties were characterized by superconducting quantum interference device (SQUID) magnetometer. The Mössbauer spectra were recorded using a conventional spectrometer of the electromechanical type with a ^{57}Co source in a rhodium matrix. The obtained Mössbauer spectra were analyzed by a least-squares fitting program.

3. EXPERIMENT RESULTS

The X-ray powder diffraction experiment on $FeGa_2O_4$ was performed at room temperature. The diffraction patterns analyzed showed a single-phased material without any impurities. The crystal structure of $FeGa_2O_4$ is determined to be an inverse spinel.

4. DISCUSSION

We conclude that spin-redistribution by distribution of Fe-cations depends on A and B-site with increasing temperature.