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Magnetic Properties on Ferromagnetic $FeAlO_3$.

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Introduction

Recently, there has been research interest in perovskite ABO_3 structure materials as $TbMnO_3$ and $BiFeO_3$[1,2], which show various magnetoelectric behavior. This materials have attracted potential application in information storage, sensors and spintronics. The orthorhombic $FeAlO_3$ was reported to show that the piezoelectric and the ferromagnetic effect at low temperature[3,4].

We have studied magnetoelectric properties of the $FeAlO_3$ by the Mössbauer spectroscopy and vibrating sample magnetometer(VSM).

Experiment

The $FeAlO_3$ polycrystalline have been prepared by a sol-gel method. Iron nitrate nonahydrate, aluminium nitrate nonahydrate were used as starting materials. These were dissolved in mixed solvents system(Acetic acid : ethanol : distilled water = 5 : 14 : 1). The solution was refluxed for 24 hr at 70 ^oC. The single phase of $FeAlO_3$ was obtained by sintering at 1400 ^oC for 1 hr in air atmosphere. Crystalline structure of the sample was examined by x-ray diffraction with Cu-Kα radiation. Magnetic and electric properties were measured by using a VSM and resistance measurements.

Results and discussion

The crystal structure of $FeAlO_3$ was determined to be a orthorhombic(Pna21) structure with its lattice constants a0= 4.983 Å, b0= 8.554 Å, and c0= 9.239 Å, respectively.

The temperature dependence of magnetization curve was measured from 65 to 320 K ranges. The hysteresis curves for $FeAlO_3$ showed ferromagnetic phase as shown in Fig.1. It is noticeable that magnetic hysteresis curve shows a pinched-like shape, which is related with a spin torque effect of nanoring materials. The saturation magnetization and coercive force were found to be 39.4 emu/g and 1,045 Oe at 65 K. The Curie temperature, T_C, is determined to be 250 K from temperature dependence of magnetization curve under the applied field of 100 Oe. It accords with the result of Mössbauer spectroscopy analysis, too.

Figure 2 shows Mössbauer spectra at various temperatures. The isomer shifts at room temperature are 0.32 mm/s and 0.11 mm/s relative to -Fe metal at room temperature, which is consistent with ferric (Fe3+) in oxide materials. The quadrupole splitting was vanished due to the random orientation of ΔE_Q below the Curie temperature, while above the Curie temperature it was not zero. The average quadrupole splitting value at room temperature is ΔE_Q = 0.66 mm/s. The Mössbauer lines are sharp at 4.2 K and become broader with increasing temperature. In order to explain the line broadening and the line-width difference in 1, 6 and 3, 4 on Mössbauer absorption spectra, we have examined the cation distribution of each Fe site using Mössbauer spectroscopy at temperatures from 4.2 K to 295 K. From the result of Mössbauer spectrum an analysis at 4.2 K, it was obtained that Fe ion occupancies on Al1, Al2, Fe1, Fe2 are 7.8, 12.4, 38.7, 41.1 %, respectively.

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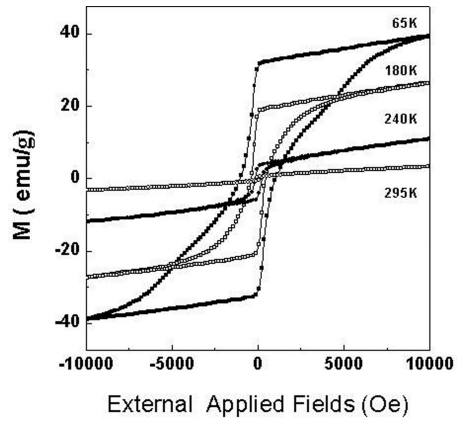

Fig.1. The Hysteresis loops at the various temperatures for $FeAlO_3$.

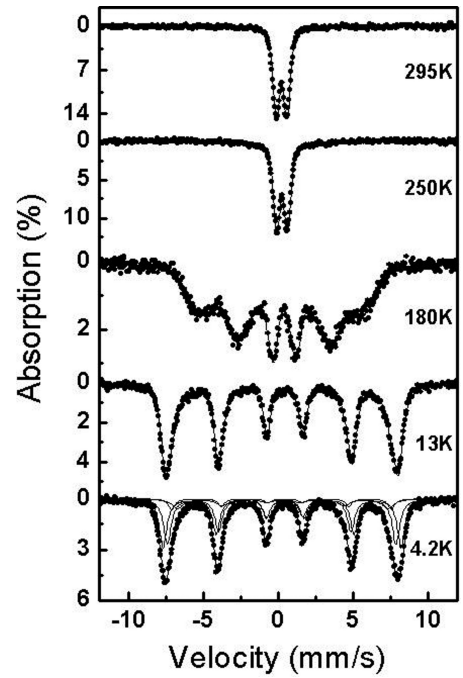

Fig.2. The Mössbauer spectra at the various temperatures for $FeAlO_3$.