Magnetic Properties on Ferromagnetic FeAlO$_3$.

J. We$^1$, S. Kim$^1$ and C. Kim$^1$
1. Department of physics, Kookmin University, seoul 136-702, South Korea

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 report-
ed 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, alu-
minium 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
°C. The single phase of FeAlO$_3$ was obtained by sintering at 1400 °C for 1 hr in air atmosphere.
Crystalline structure of the sample was examined by x-ray diffraction with Cu-Kα radiation. Mag-
netic 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 lat-
tice constants a$_0$= 4.983 Å, b$_0$= 8.554 Å, and c$_0$= 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
ferrie (Fe$^{3+}$) in oxide materials. The quadrupole splitting was vanished due to the random orienta-
tion of $\Delta E_Q$ below the Curie temperature, while above the Curie temperature it was not zero. The
average quadrupole splitting value at room temperature is $\Delta E_Q = 0.66$ 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.


Fig.1. The Hysteresis loops at the various temperatures for FeAlO$_3$.

Fig.2. The Mössbauer spectra at the various temperatures for FeAlO$_3$. 