# Effects of cation distribution for $AFeO_3$ ($A$=Ga, Al)

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Piezoelectric and ferrimagnetic $AFeO_3$ ($A$=Ga, Al) samples have been prepared by various annealing conditions and then their hyperfine structures have been investigated by x-ray diffraction and Mössbauer spectroscopy. From the analysis of the x-ray diffraction patterns by Rietveld refinement method, the crystal structure of samples was found to be an orthorhombic structure ($Pc2_1n, Pna2_1$) with four different cation sites which are labeled A1 and A2 (predominantly occupied by gallium and aluminum ions) and Fe1 and Fe2 (predominantly occupied by Fe ion). The crystal structure is not changed between the samples, but the occupancies of Fe ions in four cationic sites show slight difference. We notice that the occupancies of Fe ion in A1 tetrahedral site of the samples have an effect on the magnetic properties. From the x-ray diffraction results, the ratios of occupied Fe ions in A1 site were determined to be 9.0%, 9.5%, and 7.8% for slow-cooled $GaFeO_3$, quenched $GaFeO_3$, and $AlFeO_3$, respectively, which accord with the result of Mössbauer spectroscopy. We found that the Néel temperature range decreases from 265 to 250 K, with decreasing the Fe–O–Fe bond angles between $GaFeO_3$ and $AlFeO_3$. Also, external field dependence of magnetic moment curve shows a several-stepped shape which is similar with the exchange-spring magnet. It could be explained distinctly by an effect of Fe ion distribution in hyperfine structure.
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