Improved Magnetic Anisotropy of YMn1–xCrxO3 Compounds

Y. J. Yoo1, J. S. Park2, J. -H. Kang3, J. Kim4, B. W. Lee4, K. W. Kim5, Y. P. Lee1

1Department of Physics, Hanyang University, Seoul, 2Institute of Basic Sciences and Department of Physics, Sungkyunkwan University, Suwon 446-740, 3Department of Nano & Electronic Physics, Kookmin University, Seoul, 4Department of Physics, Hankuk University of Foreign Studies, Yongin, 5Sunmoon University, Asan, Korea

Recently, hexagonal manganites have attracted much attention because of the coexistence of ferroelectricity and antiferromagnetic (AFM) order. The crystal structure of hexagonal manganites consists of MnO₅ polyhedra in which Mn³⁺ ion is surrounded by three oxygen atoms in plane and two apical oxygen ions. The Mn ions within Mn-O plane form a triangular lattice and couple the spins through the AFM superexchange interaction. Due to incomplete AFM coupling between neighboring Mn ions in the triangular lattice, the system forms a geometrically-frustrated magnetic state.

Among hexagonal manganites, YMnO₃, in particular, is the best known experimentally since the f states are empty. In addition, for applications, YMnO₃ thin films have been known as promising candidates for non-volatile ferroelectric random access memories. However, YMnO₃ has low magnetic order temperature (∼70 K) and A-type AFM structure, which hinders its applications.

We have synthesized YMn₁₋ₓCrₓO₃ (x = 0, 0.05 and 0.1) samples by the conventional solid-state reaction. The powders of stoichiometric proportions were mixed, and calcined at 900°C for YMn₁₋ₓCrₓO₃ for 24 h. The obtained powders were ground, and pressed into 5-mm-thick disks of 1/2-inch diameter. The disks were directly put into the oven, and heated up to 1,300°C and sintered in air for 24 h. The phase of samples was checked at room temperature by powder x-ray diffraction using a Rigaku Miniflex diffractometer with Cu Kα radiation. All the magnetization measurements were carried out with a superconducting quantum-interference-device magnetometer. Our experiments point out that the Cr-doped samples show the characteristics of a spin-glass state at low temperatures.

Keywords: Multiferroic, YMnO₃, Structural properties, Magnetic properties