Evolution of Ferromagnetic and antiferromagnetic orders in Mn-doped $CaRuO_3$

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The relationship between metal-insulator transition and magnetism in the transition-metal oxides is one of the intriguing issues in the condensed-matter physics. The distorted perovskite compound $CaRuO_3$ (the $GdFeO_3$-type orthorhombic structure; space group *Pnma*) is considered to be a paramagnetic metal located in the vicinity of the metal-insulator transition. It is revealed that the ionic substitutions for the Ru site dramatically enhance the magnetic correlation [1, 2, 3, 4]. We recently found that the substitution of Mn for Ru induces both ferromagnetic and antiferromagnetic (AF) components in the magnetization, accompanying the variation of the electrical resistivity from metallic to insulating behavior. These features are expected to be attributed to the change of the d electronic state. To investigate the microscopic properties of the d electrons in the intermediate Mn concentration range, we have performed powder neutron diffraction experiments for $CaRu_{1-x}Mn_xO_3$.

The polycrystalline samples of $CaRu_{1-x}Mn_xO_3$ with $x = 0.4$ were prepared by the solid-state method. The neutron diffraction measurements for powdered samples were performed in the temperature range between 15 K and 290 K, using the HERMES spectrometer (IMR, Tohoku Univ.) installed at the guide hall of the research reactor JRR-3M of JAEA. The wavelength of the incident neutron was selected to be 1.8264 Å. Figure 1(a) shows low-angle part of the neutron powder diffraction profiles at 15 K and 290 K for $x = 0.4$. The (110) and (011) Bragg peaks are clearly observed at 15 K, which attributes the occurence of the G-type AF order. In addition, the enhancement of the (020) Bragg-peak intensity due to ferromagnetic order was also detected. Temperature variations of these Bragg-peak intensities [Fig. 2(b)] are consistent with characteristics seen in the magnetization: the magnitude of magnetization is markedly suppressed below ~ 90 K.

References

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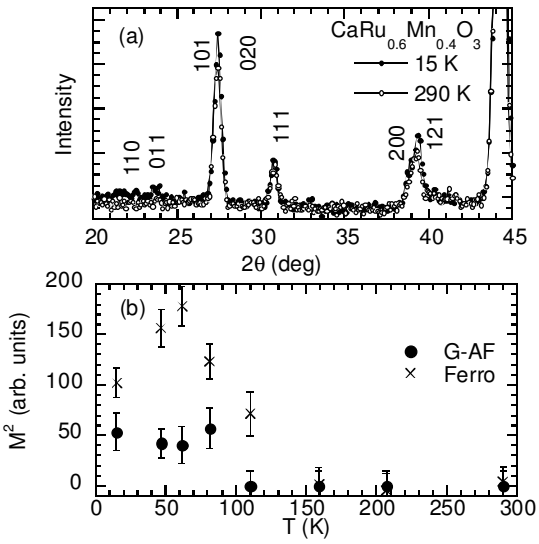

Fig. 1. (a) Neutron powder diffraction profiles at 15 K and 290 K, and (b) Temperature variations of the square of the ferromagnetic and antiferromagnetic moment for $CaRu_{1-x}Mn_xO_3$ with $x = 0.4$.