Ferromagnetic and antiferromagnetic orders in $CaRu_{1-x}Mn_xO_3$

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The nature of metal-insulator transition 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 paramagnetic metal, and located in the vicinity of the metal-insulator transition. Recently, it is revealed that the ionic substitutions for the Ru site dramatically enhance the magnetic correlation [1, 2, 3, 4]. In particular, we found that the substitution of Mn for Ru induces both the ferromagnetic and antiferromagnetic (AF) components in magnetization M, accompanying the variation of the electrical resistivity from metallic to insulating behavior. These features are expected to be attributed to the variations of the d electronic state, and it is therefore interesting to investigate the microscopic properties of the d electrons in the intermediate Mn concentration range. In the present study, 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 $x = 0.4$ 0.6 and 0.7 were prepared by the solid-state method. The neutron diffraction measurements for powdered samples were performed in the temperature ranges between 15 K and 290 K, using the HERMES spectrometer installed at the research reactor JRR-3M of JAEA. The wavelength of the incident neutron was selected to be 1.8264 Å. Figure 1 shows the neutron powder diffraction profiles at 15 K for $x = 0.4$, 0.6 and 0.7. We have observed the development of Bragg peaks ascribed to the AF order with the G-type structure. These AF Bragg-peak intensities increase with increasing x, indicating that the AF structure becomes stable in the Mn-rich concentration range. Furthermore, the intensities of some Bragg-peaks, such as the (101) and (020) peaks, are found to show notable temperature variations. They are roughly in proportional to $M^2(T)$, suggesting that the ferromagnetic order develops in the intermediate x range. These features are roughly consistent with the previous report on the Mn-rich region [5]. The precise analysis on the present neutron diffraction data is now in progress.

References

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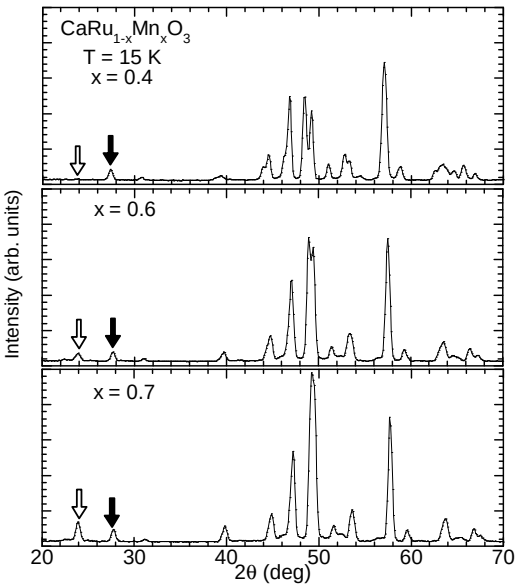

Fig. 1. Neutron powder diffraction profiles of $CaRu_{1-x}Mn_xO_3$ with $x = 0.4$, 0.6 and 0.7 at 15 K. The open and closed arrows indicate the antiferromagnetic and ferromagnetic Bragg peaks positions, respectively.