

Study of the Spin/Charge/Orbital Ordering of Transition-Metal Oxides Using X-ray Scattering and Multiple X-ray Diffraction

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The layered ruthenate compounds have attracted a great of attention because of the discovery of the many unusual physical properties, such as the superconductivity in Sr_2RuO_4 , and bad metallic non-Fermi-liquid behaviour in SrRuO_3 . More recently, the other family compound BaRuO_3 have been observed to show the unusual transport behaviour, a metallic-insulator transition at $T \approx 100$ K due to the formation of a pseudo-gap, which has been suggested to be due to the formation of a charge-density waves (CDWs) at low temperature. Previously, using an *in-vacuum* camera on beamline BL201, we located some weak spots at $T=30$ K, which were observed to double the unit cell along the C^* -axis. The further confirmation was done on beamline BL12B2 using x-ray scattering.

The tiny crystal was glued on the cold head of a cryostat mounted on a 6-circle diffractometer. The use of the multi-circle diffractometer allows us to perform scans along the any axis on the reciprocal space. The crystal was first cooled down to $T=10$ K, and CDW satellites were located at positions $(0\ 0\ 7.5)$, $(0\ 0\ 10.5)$, $(0\ 0\ 13.5)$, $(0\ 0\ 12.5)$, and $(0\ 1\ 15.5)$, and so on.

Cares were pried to track the evolution of the peak intensity as a function of temperature. The satellite reflections almost disappeared at $T_{C1} \approx 84$ K, which is in agreement with the transport measurement. Figure 1 shows the plot of the integrated intensity versus temperature. The CDW was observed to display a two-step like transition at T_{C1} and T_{C2} respectively. The transition at T_{C1} can be claimed to be caused by the formation of CDW, while the host structure did not show any change at this temperature. Further cooling, we observed that the CDW displayed a two-step like transition involving a second transition at T_{C2} . In order to understand this transition, we also measured the Bragg peak $(0\ 0\ 15)$. As shown in figure 1, the Bragg peak which reflects the behaviour of the host structure also shows a transition at T_{C2} . From the susceptibility measurement, R. J. Cava et al. observed a ferromagnetic transition at 50 K as the field was applied along c-axis. We did not expect to see this ferromagnetic phase transition using x-ray scattering. However, this unusual behaviour is of need to be further investigated.

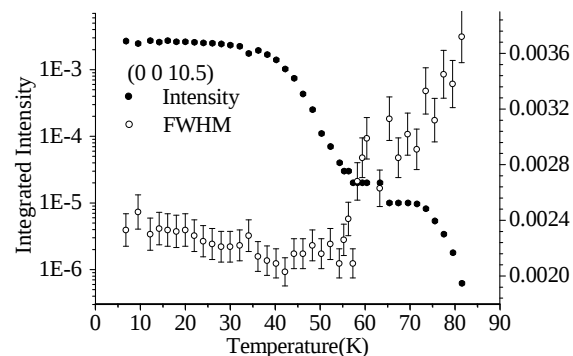


Figure 1. Evolution of the integrated intensity of CDW satellite reflection and Bragg reflection versus temperature. Longitudinal scans through both CDW satellite reflection $(0\ 0\ 7.5)$ and Bragg peak $(0\ 0\ 15)$ as a function of temperature.