Observation of charge ordring in $La_{2-x}Sr_xCoO_4$ ($0.6<x<1$) studied by neutron diffraction

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Previous studies in K_2NiF_4 type lanthanum strontium cobalt oxide $La_{2-x}Sr_xCoO_4$ (LSCoO) have shown an anomaly at about 825 K in resistivity for x=0.5, while neutron scattering have observed Co^{2+}/Co^{3+} checkerboard type charge ordering below 750 K. Furthermore, incommensurate antiferromagnetic ordering has been observed below 60 K, and a relationship with stripe ordering has been discussed [1-3]. For $0.39\leq x\leq 0.73$, including the highly doped region, lattice-incommensurate superlattice reflections due to charge ordering have been observed in $Pr_{2-x}Ca_xCoO_4$ from neutron scattering [4]. On the other hand, the magnetic properties of LSCoO have been studied at low temperatures up to x=0.75, but there have been few reports on the charge-ordered phase at high temperatures [5,6]. Recently, we found an anomaly in resistivity of highly doped LSCoO at x=0.7, 0.75, and 0.8 in 340-280 K, which may originate from charge ordering. We performed neutron scattering experiments to confirm whether this anomaly is indeed due to charge ordering. The experiment was carried out in JRR3 6G-TOPAN in the temperature range of about 20-380 K using high-temperature CTI. The sample was oriented vertically along the <110> of tetragonal system (*i.e.*, *a*-axis of orthorhombic system), which is defined as the *h* direction, and the rotating plane was the *h*-*l* plane. The charge ordering was measured with an *h*-scan of (*h* 0 7) in order to indirectly observe the atomic displacements as diffuse scattering, with as large a *Q* as possible and avoiding nuclear reflections on the lattice.

We observed broad diffuse scattering at lattice-incommensurate positions, $h=2m\pm2\varepsilon$ (m=0, ±1, ...) in *h*-scans with l=7, at room temperature for x=0.75 and overlapped by one for x=0.7 and 0.8 (Fig. 1). This peak is not clearly observed at l=2, where *Q* is small, and no antiferromagnetic magnetic ordering is reported at room temperature, suggesting that these incommensurate peaks likely due to charge ordering. The temperature dependence of these peaks remained almost the same from a low temperature of about 20 K to 375 K. These results suggest that the anomaly observed in the resistivity at high temperatures possibly originates from charge ordering, but the temperature difference needs to be studied further.

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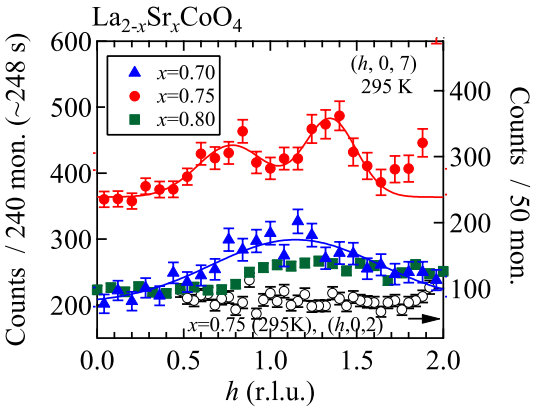

Fig. 1. Neutron scattering in l=7 of $La_{2-x}Sr_xCoO_4$ for x=0.7, 0.75 and 0.8 at room temperature , and l=2 for x=0.75.