Resonant soft X-ray scattering and spectroscopic study of Co^{3+} intermediate-spin state in RT ferromagnet $Sr_3YCo_4O_{10.5}$

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$Sr_3YCo_4O_{10.5}$ (SYCO) shows the highest ferromagnetic transition temperature of T_C ~ 370 K in Co perovskite[1]. Since Co ion is trivalent and crystal structure transition appears at T_C, it is expected that some structure ordering and Co^{3+} spin state degrees of freedom, such as high-spin(HS), intermediate-spin(IS), and low-spin(LS) states, may contribute to the RT ferromagnetism. Co *K*-edge resonant X-ray scattering revealed that x^2-z^2/y^2-z^2 type e_g orbital ordering occur in *ab* plane below T_C. This means that Co^{3+} ion takes IS state[2]. Direct information of the Co *3d* and ligand O *2p* electronic structures on Co^{3+} IS state and e_g orbital ordering is required to clarify how the e_g orbital ordering and Co^{3+} IS state affect on the RT ferromagnetism.

We have measured Co $L_{2,3}$ and O *K* edge XAS to study the Co^{3+} spin state. By comparing Co $L_{2,3}$ edge XAS of SYCO with $LaCoO_3$ in Fig.1 (a), SYCO spectrum shows different L_3 shoulder and L_2 peak characters from those of Co^{3+} LS state. Thus SYCO is deduced to take Co^{3+} HS/IS states. We have also measured Co $L_{2,3}$ and O *K* edge resonant soft X-ray scattering (RSXS) of orderings which relate with e_g orbital and spin state orderings. Figure 1 (b) show Co $L_{2,3}$ edge RSXS energy scans of (2 0 0) under σ and π polarizations. There are many different characters but especially at 777 eV, where difference of spin state appears in XAS, appearance and disappearance of a sharp peak is observed. In the presentation we will show results of spectral analyses of XAS and RSXS energy scans for further discussion.

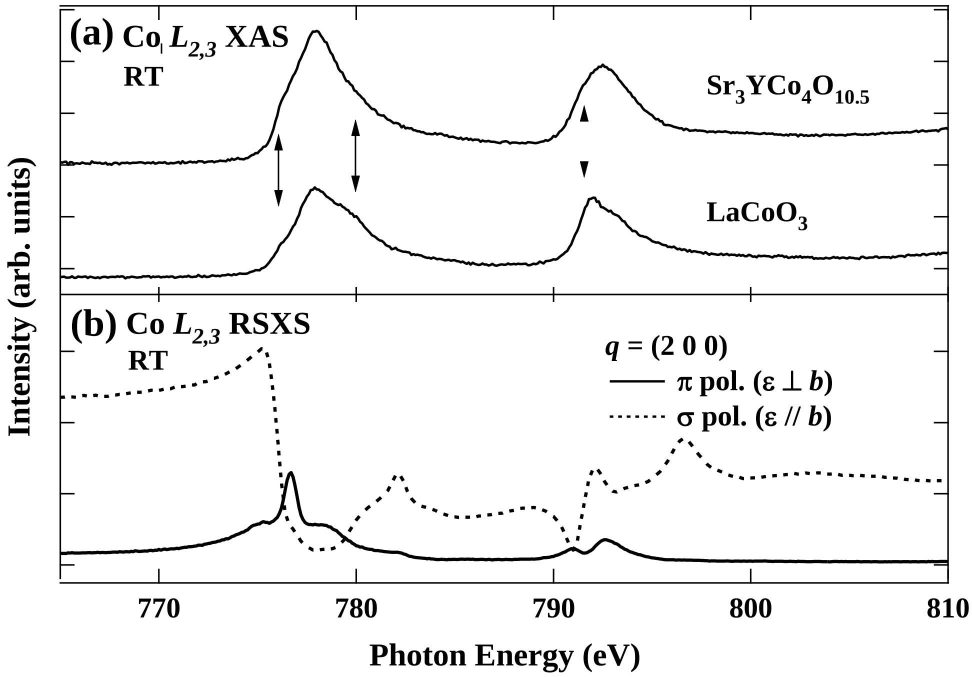

Fig. 1: (a) Co $L_{2,3}$-edge XAS spectra of SYCO and $LaCoO_3$, and (b) RSXS energy scans of q = (2 0 0) under σ and π polarizations.

[1] W. Kobayashi *et al.*, Phys. Rev. B **72**, 104408 (2005).
[2] H. Nakao *et al.*, J. Phys. Soc. Jpn. **80**, 023711 (2011).