

Er-L edge resonant elastic X-ray scattering study of orbital ordering ErVO₃

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Introduction

ErVO₃ is one of an archetypal material of a t_{2g} -orbital ordering system. Coupling of large orbital fluctuation and a lattice distortion causes two kinds of a characteristic order of d_{yz} and d_{zx} orbital. Below 195 K, these two orbitals are staggered three-dimensionally, namely the G-type orbital order (G-OO). With more decreasing a temperature, they are aligned along c-axis below 60K corresponding to the phase transition from the G-OO to the C-OO [1]. Recently, pressure-experiment with a diamond-anvil-cell has found an elevation of the transition temperature of the C-OO and decay of the G-OO under a pressure. To explain the pressure effect, a covalency of the vanadium and surrounding ions (oxygen, A-site cation) is important as well as the band-width effect (Fig.1) [2].

Results and Discussion

In order to clarify a relationship between the covalency effect and the orbital ordering state, we performed the resonant scattering experiment (RXS) on ErVO₃.

By using the Er L₃-edge by 8.358 keV, we observed (100) reflection corresponding to an anisotropy of the 5d electron state on Er-site caused by making a covalent bonding with the t_{2g} orbitals of vanadium. We also measured incident energy dependence of the (100) reflection near the Er L₃-edge, in order to observe an energy shift associated to creation of the covalent bond (Fig.2 a). Temperature dependence of RXS intensity and peak energy at the main edge is shown in Fig.2 b. Both the intensity and resonant energy show gradual change with decreasing a temperature, and they do not suggest remarkable temperature dependence at any transition temperatures. On the other hand, in the G-OO state, the resonant energy becomes lower than the other phase. This is one of a possibility of the covalency effect on electronic state between V orbital order and the Er site.

References

- [1] S. Miyasaka et al., Phys. Rev. B, 68, 100406 (2003).
 [2] D. Bizen et al., Phys. Rev. B, 78, 224104 (2008).

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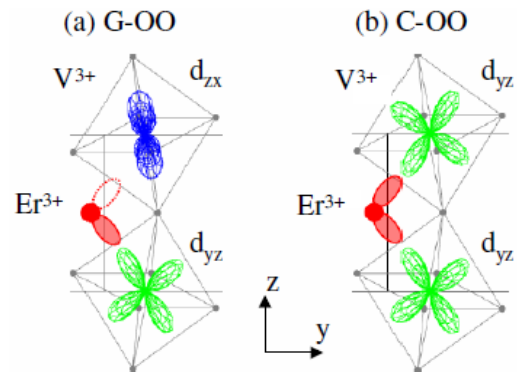


Fig.1 The schematic models of orbital order of t_{2g} orbitals of V³⁺ and 5d orbital of Er³⁺ in ErVO₃. (a) In the G-OO, hybridization between the 5d and one of the t_{2g} can be realized. (b) In the C-OO, two of the t_{2g} are available.

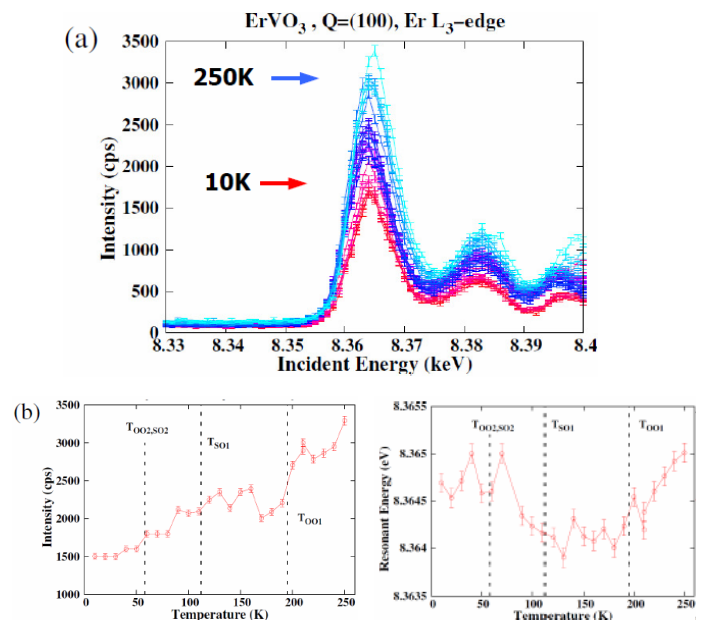


Fig.2 (a) RXS spectra of ErVO₃. (b) Temperature dependence of an intensity and resonant energy of the RXS spectra. Dash lines denote the transition temperatures of the orbital and spin ordering.