Er L3-edge resonant elastic x-ray scattering study of orbital ordering in $ErVO_3$

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In ErVO3, the C-OO and G-type spin order (G-SO) are observed in the ground state. With increasing temperature, the orbital and spin state are transformed to the G-OO and C-type spin order (C-SO) at TOO2 = TSO2 = 74 K. The transition temperatures for these two transformations are TOO1 = 195 K and TSO1 = 118 K, respectively[1]. Recently, the orbital ordering in RVO3 (R: rare earth) under high pressure was systematically studied, and the C-OO was found to be much more stable than the G-type orbital ordering (G-OO)[2]. This was attributed to the covalency between the R d and V 3d orbitals. The C-OO phase has the ferroic arrangement of V 3d orbital along the c axis, as shown in Fig. 1(a), and the covalency between the R d and the V 3d orbitals is enhanced along this axis. However, that is not the case in the G-OO phase since the V 3d orbitals show a staggered arrangement along the c axis. Consequently, it is thought that the energy gain due to the covalency is larger in the C-OO phase than in the G-OO phase when the covalency is increased by applying pressure. To elucidate the covalency between the R d and V 3d orbitals, we studied RXS at the R-ion absorption energy. ErVO3 shows C-OO, G-OO, and orbital disordered phases. Hence, the covalencies of these phases can be compared. Moreover, RXS at the Er L3-edge can help directly evaluate the Er 5d state, which is related to the covalency. Therefore, in this work, we performed an RXS experiment near the Er L3-edge in ErVO3.

The RXS experiment was carried out on the bending magnet beam line BL-4C at the Photon Factory in KEK. A resonating signal is clearly observed at the Er L3-edge. The azimuthal-angle dependence of the scattering intensity shows a twofold symmetry at the peak energy (E) of 8.368 keV, which is the same as the dependence observed in the case of RXS at the V K-edge. RXS reveals an alternative order of anisotropy for the Er 5d orbitals. This anisotropy should change at the transition from the G-OO to the C-OO if the covalency plays an important role in this transition. The temperature dependence of the energy spectrum was determined (Fig. 2). When the temperature decreased, the shape of the energy spectrum did not change, while the intensity gradually decreased. There was no anomaly at the transition temperatures.

In this presentation, we will discuss the relationship between the anisotropy of the Er 5d orbital and the V 3d orbital ordering in the $ErVO_3$.

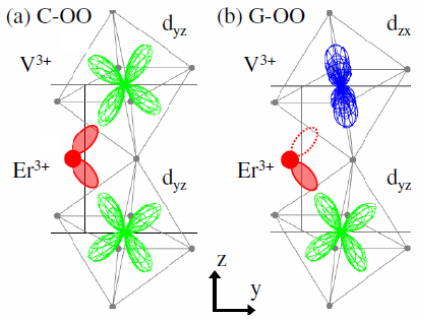

Fig.1 Schematics of (a) the C-OO and (b) the G-OO along the c axis.

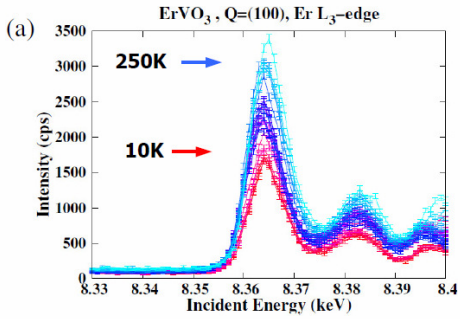

Fig.2 Temperature dependence of the RXS spectra.

References

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[2] D. Bizen et al., Physical Review B, 78, 224104 (2008).