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Charge ordered state in Yb_4As_3 studied by resonant x-ray scattering

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Introduction

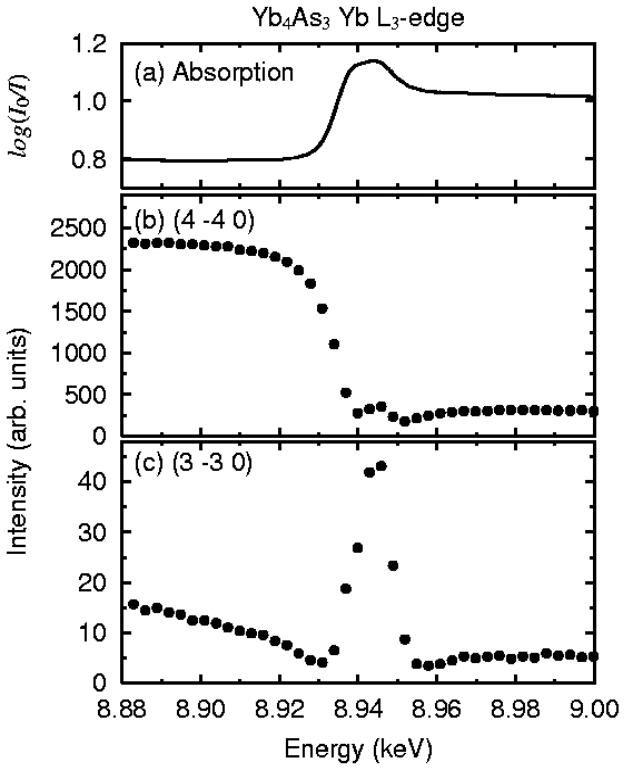
Valence fluctuation is one of the anomalous physical phe_nomena in the rare earth compound. Yb_4As_3 with anti-Th_3P_4 type cubic crystal structure shows typical valence fluctuated state. [1] Only one kind of Yb ion crystallographically exists in the structure and the valence should be +2.25. However, the difference valence states, Yb^{2+} and Yb^{3+}, have clearly observed by x-ray absorption spectra, photoemission and reflectivity spectra. [2] As a result, the thermally fluctuated valence state is expected in this compound. Moreover, the compound also shows the charge ordering of the Yb (2+/3+) ion at T_C ~290 K. Namely, it is expected that the fluctuating frequency decreases with decreasing temperature and the static charge ordered state finally emerges below T_C. However, the charge distribution in the valence fluctuated state has never been measured by x-ray diffraction technique. As a first step to study the valence fluctuated state, in this study, we have investigated the charge ordering of Yb ion using resonant x-ray scattering (RXS), which is a quite suitable technique for the study of charge ordered state. [3]

Experiment

To check the sample quality and the crystal structure, the powder and single crystal x-ray diffraction was performed by the micropowder diffractmeter equipped with an imaging plate at beamline (BL) 1B. [4] The space group was checked above/below T_C and is consistent with a previous report. X-ray scattering near the Yb L-absorption edge energy was carried out at the BL-4C. A four-circle diffractometer equipped with a cryostat was used.

Results

To determine the Yb L_3-edge, the absorption spectrum of the powder sample has been measured at room temperature as shown in Figure (a). The spectrum can be clearly explained as the absorption of the Yb^{3+} and Yb^{2+}. The energy dependence of the peak intensity at fundamental reflection (4 -4 0) (Figure. (b)) also shows the absorption effect at the Yb L_3-edge. In order to find the RXS owing to the charge ordering, the energy dependence of the scattering intensity at the several reflections was measured below T_C. We have clearly found the RXS at (3 -3 0) showing the resonant feature at the edge (Figure.(c)). On the basis of the quantitative RXS intensity, we have tried to calculate the valence state at respective Yb site.



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