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Temperature-dependent Eu 4f spectra of $EuPd_2Si_2$ probed by high-resolution photoemission spectroscopy

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Introduction

It is well known that some Eu compounds show intermediate valence between Eu^{2+} ($4f^7$) and Eu^{3+} ($4f^6$). $EuPd_2Si_2$ undergoes an abrupt but continuous valence transition at around 160 K: the Eu mean valence changes from 2.8 below 130 K to 2.3 above 180 K [1]. In this study we have investigated the temperature dependence of Eu 4f states in $EuPd_2Si_2$ by means of Eu 4d-4f resonant photoemission spectroscopy (RPES).

Experimental

Eu 4d-4f RPES spectra at 20, 150 and 250 K were measured at BL-11D. Overall energy resolution around the Eu 4d-4f threshold was set at about 80 meV. The sample used was a polycrystalline $EuPd_2Si_2$ grown by arc melting and by annealing at 900 °C for one week. The clean surface was obtained *in situ* by fracturing and scraping under the base pressure of 3×10^{-10} Torr.

Results and discussion

Fig. 1 shows the Eu 4d-4f REPS spectra with $h\nu$ = 140.5 eV for both the fractured and scraped sample. The sample temperature was set at 250 K. The spectrum has been divided a bulk and two surface Eu^{2+} 4f components by the line-shape analysis [2, 3]. The spectrum for the fractured sample shows that the Eu^{2+} 4f states of the second surface Eu layer are strongly suppressed, while the bulk Eu 4f states become more clear and intense, in comparison with the spectrum for the scraped sample. This suggests that at the scraped surface the local coordination around Eu atom is disordered and is not well defined, in contrast with the original atomic coordination of tetragonal $ThCr_2Si_2$-type structure. Thus, for the scraped sample not only two surface Eu layers but also several Eu underlayers may contribute differently to the Eu 4f spectrum besides the bulk.

Fig. 2 shows the temperature dependence of the Eu 4d-4f RPES spectra measured at 150 eV for the fractured sample. In Fig. 2 vertical lines indicate the position and relative intensity of multiplet structures for the bulk and the surfaces [2]. As temperature increases, the spectral intensity of the bulk Eu^{2+} 4f states around 0.7 eV drastically increases whereas that of the Eu^{3+} 4f states from 6 to 11 eV decreases. It is considered that the change in the intensities of the bulk Eu 4f states is related to the valence transition of $EuPd_2Si_2$ [1].

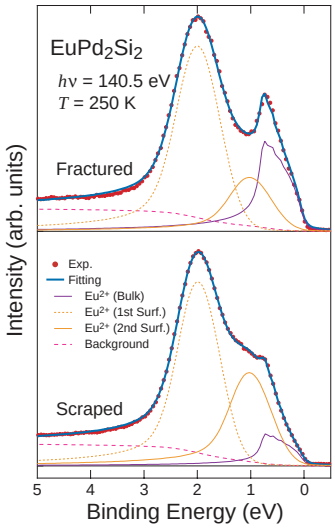

Fig. 1. Eu 4d-4f RPES spectra of $EuPd_2Si_2$ for both the fractured and scraped sample.

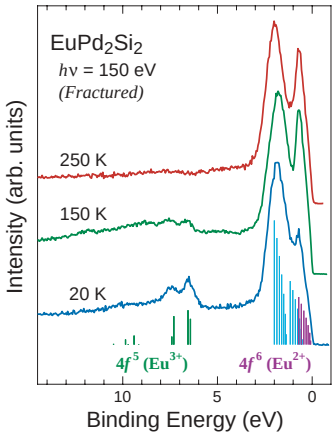

Fig. 2. Temperature dependence of the RPES spectra for the fractured sample, taken at $h\nu$ = 150 eV.

References

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