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L_3-edge XAFS Measurements of Valence Fluctuating Eu-based Antiferromagnets.

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Introduction

$EuPt_2Si_2$, which crystallizes in the tetragonal $CaBe_2Ge_2$ type structure, exhibits antiferromagnetic ordering at T_N=15 K and Curie-Weiss susceptibility with an effective magnetic moment close to $Eu^{2+}(4f^7)$ at T>15 K. However, the Eu valence estimated from ^{151}Eu Mössbauer effect [1] at room temperature shifts a little toward a $Eu^{3+}(4f^6)$ state, compared with the other antiferromagnets with a stable Eu^{2+} ion. Recently, we found 15% substitution of Ni for Pt suppresses the antiferromagnetism. It is expected that the substitution destabilizes a magnetic Eu^{2+} state. In the present study, we investigate the Eu valence of $Eu(Pt_{1-x}Ni_x)_2Si_2$ as a function of temperature by measuring the XAFS at the Eu L_3-edge.

Experimental

The polycrystalline samples of x=0~0.25 were prepared by arc-melting constituent elements under Ar atmosphere and subsequent annealing in an evacuated quartz tube at 1173 K for 1 week. The XAFS measurements at the Eu L_3-edge were performed at BL-9A and BL-12C beamlines of KEK Photon Factory using a Si(111) double crystal monochromator in the temperature range of 10 - 300 K.

Results and Discussion

All the measured XAFS spectra consist of two subspectra, the ($2p^54f^75d^*$) and ($2p^54f^65d^*$) final state components, as shown in Fig. 1. This directly indicates the valence fluctuating behavior. The spectra were analysed by fitting two sets of a Lorentzian and an arctangent-function. The mean valence is estimated from the relative intensity of the two subspectra. Figure 2 shows the mean valence of the samples as a function of temperature. For the pure sample (x=0), the Eu valence at room temperature is estimated to be 2.27 and confirmed to deviate toward a trivalent state from the valence of the other Eu-based antiferromagnets (e.g. 2.15 for $EuCu_2Ge_2$ [2]). In addition, the valence changes toward the trivalent state with decreasing temperature in spite of performing antiferromagnetism. With substituting Ni for Pt, the valence vs T curves shift toward the trivalent direction. The valence of x=0.25 reaches 2.6 at 10 K. Comparing the results of x=0.12 (an antiferromagnet) and x=0.15 (without magnetic ordering), we cannot observe qualitative differences in behavior between them. In the present system, we cannot observe sharp and large valence transition which is seen in $EuPd_2Si_2$ and $EuNi_2(Si_{1-x}Ge_x)_2$.

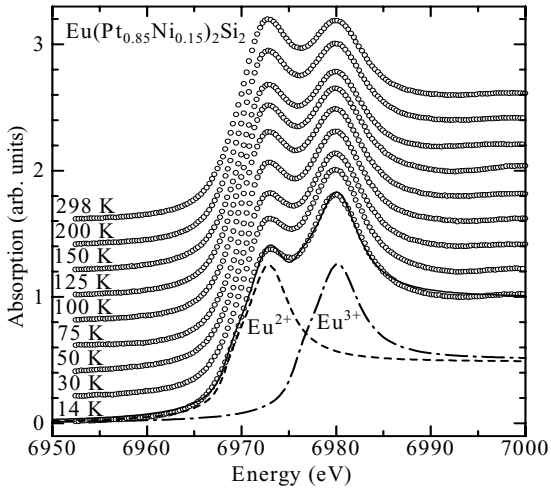

Fig. 1 The XAFS spectra of $Eu(Pt_{0.85}Ni_{0.15})_2Si_2$ at the Eu L_3-edge at various temperatures.

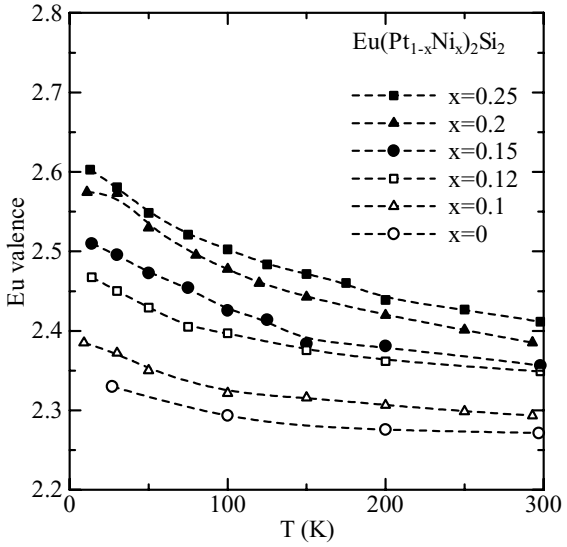

Fig. 2 Temperature dependence of the mean Eu valence for $Eu(Pt_{1-x}Ni_x)_2Si_2$.

References

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