Materials Science

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Resonant X-ray Scattering at Zn K-absorption edge in $K_xZn_{1-x}F_3$

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Introduction

Impurity effect on ordered states of strongly correlated electron systems has attracted a great deal of interest. For example, the Zn doping into high Tc cuprates makes the new quasiparticle electronic state near the Zn site with the strong suppression of the superconductivity. We have been interested in the impurity effect on orbitally ordered systems and investigated the effect on a typical orbital ordering system $KCuF_3$ by substituting Zn for Cu.

It has been found that the orbital ordering disappears at $x = 0.543 \pm 0.005$ with decreasing Cu concentration. This order-disorder concentration is much lager than that of the spin percolation threshold in the three-dimensional system. The result is consistent with the recent theoretical work. The theory predicts the local orbital pseudo-spin of the Cu ions neighboring on the Zn ions is fairly tilted.

Resonant X-ray Scattering (RXS) is very powerful technique to study the orbital ordering. Here we have applied this technique to study the local electronic state near the impurity Zn using Zn K-absorption edge in $K_xZn_{1-x}CuF_3$. The RXS from impurity ions has been observed for the first time.

Experimental Results

EXAFS Experiment at Cu and Zn K-absorption Edges

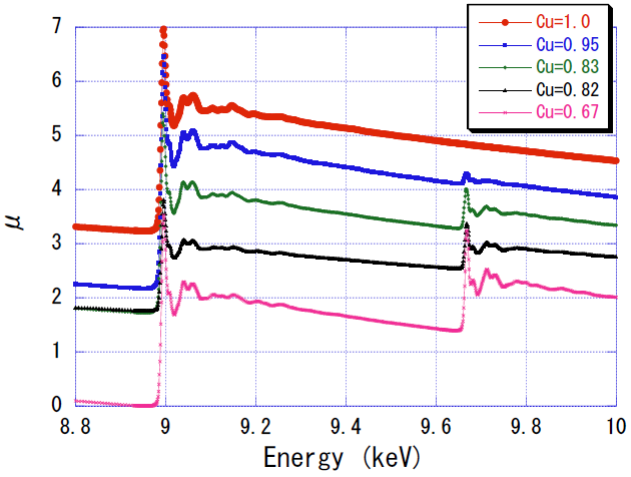

Figure 1. Energy dependence of the absorption coefficient near Cu and Zn K-absorption edge energies in $K_xZn_{1-x}CuF_3$.

High quality single crystals were grown using Bridgman method. Powder samples with uniform concentration were prepared by crushing the single crystals. The result of the absorption experiments is shown in Fig. 1. Analyzing the data we have determined the distances between Cu or Zn ions and fluorine ions. It is found that the distances around Zn are more isotropic than those around Cu above the critical concentration x_c. Near the x_c they become isotropic perfectly. These results are consistent with our previous study.

RXS at Cu and Zn K-absorption Edge Energies

In order to compare the local electronic state around Zn ions with that around Cu the RXS technique was applied at Zn and Cu K-absorption edge energies. The Energy dependence of the RXS intensities at Zn-K edge is shown in Fig.2. The resonant shape as a function of energy is different from that at Cu-K edge, which indicates the deference of the local electronic states around Cu and Zn ions. The azimuthal angle dependence of the Zn-RXS intensities with σ and π polarization was also measured. Increasing Zn concentration we have observed the decrease of the oscillation-amplitude and the increase of the constant part as a function of the azimuthal angle in both polarization components. This implies the local orbital pseudo-spin of the Cu around the Zn ions is tilted, which is consistent with the recent theory.

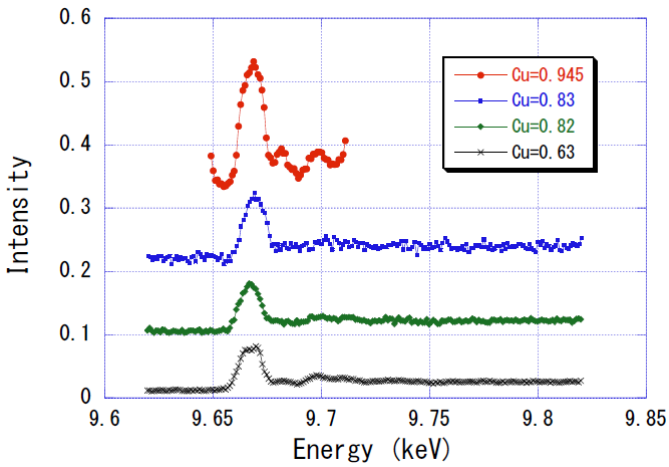

Figure 2. Energy dependence of RXS intensities near Zn K-absorption edge energy in $K_xZn_{1-x}CuF_3$.

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