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Magnetic EXAFS for Ni-Mn alloys

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Introduction

The Ni_3Mn alloy forms an ordered phase of Cu_3Au type with suitable heat treatment [1]. The magnetization depends on the number of nearest-neighbor Mn atoms around a Mn atom for Ni_3Mn [2]. According to heat treatment Mn atoms are substituted into the Ni atoms in the lattice as each Mn atom is located at the corner positions of f.c.c. lattice. These Mn pairs show ferromagnetic interaction. The magnetic EXAFS is powerful and direct method to study the local magnetic structures for such an alloy.

In this report we study the magnetic EXAFS of Mn *K*-edge for $Ni_{0.76}Mn_{0.24}$ alloy. We compare the experimental spectra with semi-relativistic theoretical calculation.

Experimental

The appropriate quantities of 99.99 % pure Ni and Mn were melted in Ar gas by the rf induction furnace, and then the ingot was homogenized by holding in a vacuum for 15 h at 1273 K. The foil samples of $Ni_{0.76}Mn_{0.24}$ prepared by polishing and annealed at 693 K for 100 hours in a quartz tube sealed under Ar atmosphere in order to obtain certain degrees of atomic order. The magnetic EXAFS spectra were measured at BL28B in transmission mode using the left-circularly polarized X-ray.

Theory

The semi-relativistic calculation for magnetic EXAFS was applied to NiMn alloys. The formalism of the calculations are presented elsewhere [3].

Results and Discussion

Figure 1 shows the Fourier transforms of the EXAFS. The *k*-range of the Fourier transform is 2.0~10.8 $Å^{-1}$. Solid lines presents magnetic and dashed line does non-magnetic EXAFS. Vertical arrows in Fig. 1 denote the crystallographic positions of nearest neighbour atoms in Ni-Mn f.c.c lattice from central Mn atom. The non-magnetic EXAFS shows these contributions quite normally. On the other hand, in the magnetic EXAFS we can observe different phenomenon that the peak intensity of the 2nd and 4th nearest neighbour peaks in the magnetic EXAFS is more prominent than that for 1st and 3rd nearest neighbours in comparison with non-magnetic EXAFS result. This phenomenon can be interpreted as follows: After the appropriate heat treatment, the Ni-Mn alloys are ordered and this ordered phase mainly generate the ferromagnetic MCD effect. In the ordered phase, Mn atoms are expected to be large magnetic moment and are rearranged at second and fourth nearest neighbour positions from Mn atom. Therefore magnetic EXAFS can detect the large contribution from 2nd and 4th nearest Mn atoms. Figure 2 shows the result from semi-relativistic calculation for the magnetic EXAFS for NiMn alloy. The peaks of 2nd and 4th are prominent in the magnetic EXAFS in comparison with non-magnetic one. The theoretical result well reproduces the experimental result.

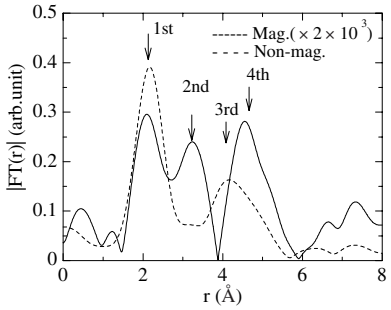

Fig. 1 Fourier transforms of magnetic EXAFS for Mn *K*-edges of $Ni_{0.76}Mn_{0.24}$ (solid line). Dashed line represents the non-magnetic EXAFS.

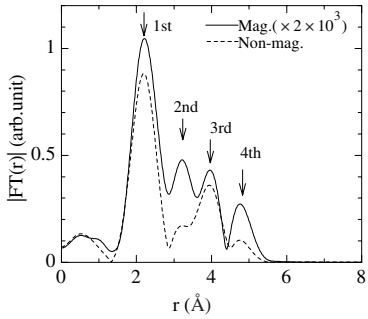

Fig. 2 Calculated Fourier transforms of magnetic EXAFS for Mn *K*-edges of Ni_3Mn model (solid line). Dashed line represents the non-magnetic EXAFS.

References

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