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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]. It has been known that increase in degrees of short-range order is accompanied by extensive changes in the magnetic and conductive properties of this alloy. That is, 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. The magnetic properties depend on the atomic short-range order so the magnetic EXAFS has a possibility to reveal the magnetic short-range order of the alloy.

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.

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 and these intensities in Fourier transform depend on the number of surrounding atoms and distance from central atom as previously reported [3,4]. On the other hand, in the magnetic EXAFS we can observe different phenomenon that the peak intensity of the second nearest neighbour peak at 3.58 Å in the magnetic EXAFS is more prominent than that for first nearest neighbour at 2.54 Å 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 nearest neighbour position from Mn atom. Therefore magnetic EXAFS can detect the large contribution from second nearest Mn atoms. We find another prominent phenomenon that the fourth contribution in magnetic EXAFS is outstanding. The positions of the fourth nearest neighbour are possessed by also Mn atoms in ordered phase. We expect that the magnetic correlation between Mn atoms in Mn-Ni-Mn structure is stronger than that in the first second nearest Mn-Mn pair. On the other hand, the focusing effect can be considered as a large peak at 4^{th} neighbour observed as magnetic EXAFS. The detailed analysis of this phenomenon is in progress.

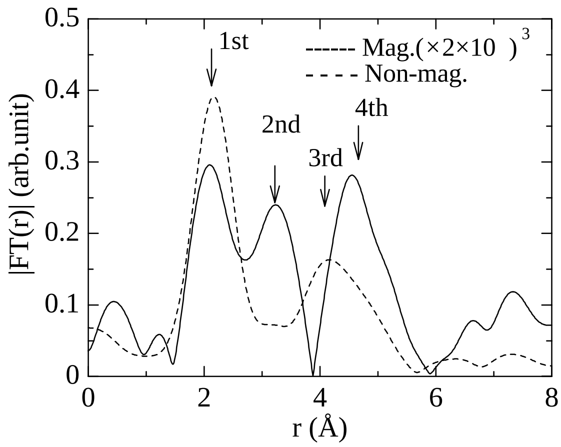

Fig. 1 Fourier transforms of magnetic EXAFS for Mn *K*-edges of $Ni_{0.76}Mn_{0.24}$ (solid line). Dashed line represents the non-magnetic EXAFS.

References

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