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Local structure analysis of MgB_2 by polarized XAFS

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Introduction

Superconductor MgB_2 was discovered in 2001 and shows the superconducting transition temperature of 39K which is the highest for metal compounds. The superconducting mechanism and applications as a device are attracting great interest. An important issue for application to a device is the production of high-quality MgB_2 thin film. So MgB_2 was deposited on the O-side ZnO single crystal. ZnO has high compliance and same hexagonal system as MgB_2.

For studying the local structure of such thin films, EXAFS is powerful tool. Using a synchrotron radiation source, polarized EXAFS analyses are available. We analyzed the local structure of 30nm, 50nm and 150nm MgB_2 thin films.

Experimental and data analyses

30nm, 50nm and 150nm MgB_2 films were prepared by co-evaporation MBE (molecular beam epitaxy) method [1].

Mg *K*-edge (1302eV) X-ray absorption spectra were measured on BL11A at Photon Factory, KEK, Tsukuba, using fluorescence mode with silicon drift detector (SDD). Polarization-dependent XAFS measurement was applied to two directions: (1) The horizontal direction of the sample in which the electric vector of X-ray, ***E***, is perpendicular to the *c*-axis of MgB_2 thin film; (2) the vertical direction in which ***E*** is parallel to the *c*-axis. The EXAFS analyses were performed by XANADU code [2] and FEFF 8.10 code [3]. We applied the non-liner least square fitting (curve fitting) method to EXAFS data and obtained the structural parameters.

Result and discussion

Fig. 1 and Fig. 2 show Fourier transforms of χ (*k*) for the horizontal direction and for the vertical direction for MgB_2 thin films. Peaks around 2.0Å, 2.8Å and 3.5Åcorrespond to 1NN (1st nearest neighbor) Mg-B, 2NN Mg-Mg and 3NN Mg-Mg, respectively. In Fig.2, 30nm film shows different spectra for others, and it has a peak of around 2.8Å which may be 2NN. We measured XRD for 30nm thin film. Whereas the XRD of 50nm and 150nm thin films shows two peaks of MgB_2 (001) and (002), but that for 30nm film has no peak. It is indicated that the present 30nm film may be amorphous.

Atomic distances for each atomic pair are shown in Table 1 for the horizontal direction and in Table 2 for the vertical direction. Generally atomic distance of amorphous is shorter than crystal. Our sample suggests the same result. In horizontal direction, the atomic distance of 50nm film was longer than that of 150nm. In vertical direction, the atomic distance of 50nm film was longer than that of 150nm. This result indicates that the structure of 50nm MgB_2 film was expanded in the *a*-*b* plane and compressed along the *c*-axis. ZnO's lattice (3.25Å) is longer than MgB_2(3.09Å). So ZnO influenced MgB_2 when MgB_2 deposited.

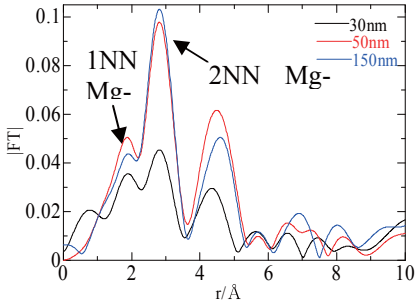

Fig. 1 Fourier transforms of χ (*k*) for horizontal direction of MgB_2 films

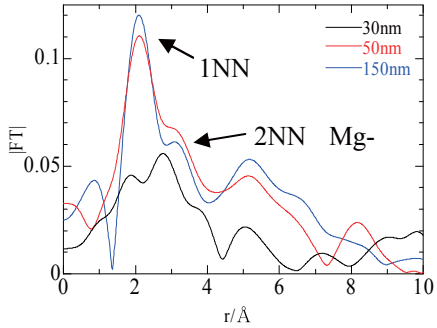

Fig. 2 Fourier transforms of χ (*k*) for vertical direction of MgB_2 films

Table 1: Atomic distances for horizontal direction

	150nm	50nm	30nm
1NN Mg-B	2.59Å	2.60Å	2.54Å
2NN Mg-Mg	3.20Å	3.21Å	3.17Å

Table 2: Atomic distances for vertical direction

	150nm	50nm	30nm
1NN Mg-B	2.58Å	2.57Å	2.53Å
3NN Mg-Mg	3.72Å	3.76Å	3.73Å

References

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