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Local structure analysis of MgB_2 thin films by polarized XAFS

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1 Introduction

MgB_2 discovered in 2001 shows the super-conducting transition temperature of 39K, which is the highest among metallic ones. The superconducting mechanism and applications as a device are attracting great interest. An important issue for the application to a device is the production of high-quality MgB_2 thin films. Although MgB_2 thin film grown-up on ZnO forms a reactive region in the interface, its crystallinity and superconductivity performance have been improved. The lattice distance of ZnO is close to that of MgB_2 (the lattice mismatch is about 5%). For studying the local structure of such thin films, EXAFS (extended X-ray absorption fine structure) is a powerful tool and the polarized EXAFS analyses are available, using a synchrotron radiation source. We analyzed the local structure of 50nm and 150nm MgB_2 thin films until now [1]. In this paper we present the results for the local structure of 10nm, 20nm and 30nm MgB_2 thin films.

2 Experiment

10nm, 20nm and 30nm MgB_2 films were prepared by co-evaporation MBE (molecular beam epitaxy) method [2]. Mg *K*-edge (1309eV) X-ray absorption spectra 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: (a) 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: (b) The vertical direction in which ***E*** is parallel to the *c*-axis. The EXAFS analyses were performed by XANADU code and FEFF 8.10 code. We applied the non-liner least square fitting (curve fitting) method to EXAFS data and obtained the structural parameters.

3 Results and Discussion

Fig. 1 and Fig. 2 show Fourier transform (FT) of $\chi(k)$ for the horizontal direction and for the vertical direction for MgB_2 thin films. Peaks around 2.0Å, 2.8Å and 3.5Å correspond to 1NN (1st nearest neighbor) Mg-B, 2NN Mg-Mg and 3NN Mg-Mg, respectively. FT for 30nm MgB_2 film is similar to that for 50nm. On the other hand, FT for10nm and 20nm films have different structure from 30 and 50 nm films. Peak for 1NN Mg-B shifts to shorter distance and FT of 10nm film shows no clear polarization dependence.

Fig. 3 is atomic distance value, which is obtained by curve fitting as a function of film thickness.

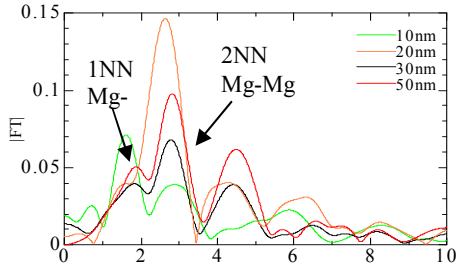

Fig. 1 FT of $\chi(k)$ for the horizontal direction MgB_2 films

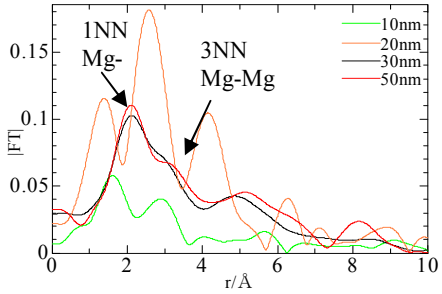

Fig. 2 FT of $\chi(k)$ for the vertical direction MgB_2 films

1NN distance becomes shorter as the film thickness is thinner. On the other hand, 2NN distance shows no clear dependence on the film thickness. Furthermore, the distance of 3NN for 10nm and 20nm are close to that of 2NN. It suggests the possibility of the structural change from the hexagonal form to tetragonal one. This is considered to be the effect of magnesium oxide.

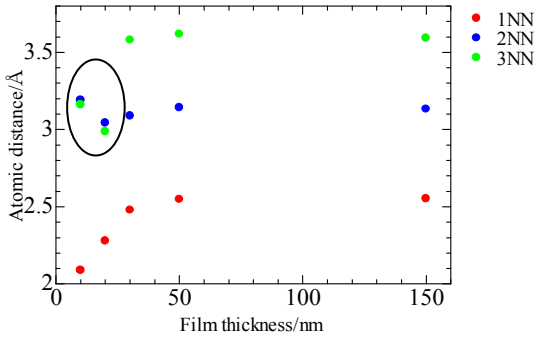

Fig. 3 Atomic distance vs film thickness

4 Reference

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