

Local Structure Analysis of Co in Co-Oxide Nanogranular films

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1 Introduction

Nanogranular film composed of Co particles embedded in oxide matrix is an attractive magnetic material, especially in the field of soft magnetic materials used at the GHz range [1,2]. Since the nanostructures of the Co-oxide nanogranular films are closely related with their physical properties, the characterization of the nanostructures is important. So far, the nanostructures of the Co-oxide nanogranular films have been characterized by a transmission electron microscope (TEM), an X-ray diffraction (XRD) and a small-angle scattering (SAS). One of the most important issues in the Co-oxide nanogranular films is a possible intermixing of Co into the amorphous oxide matrix. The Co dispersed in the matrix probably causes the change in the physical properties, such as a reduction in magnetization, a modulation of magnetic coupling, and change in transport properties. However, the previous experimental techniques like TEM and XRD are not suitable to detect the possible intermixing. The X-ray absorption fine structure (XAFS) spectroscopy can estimate the chemical states and local structure of Co. That information is useful to elucidate the function of Co in the nanogranular film. Therefore, the XAFS analyses of the Co in the Co-oxide nanogranular films were performed in this study.

2 Experiment

Samples were prepared by a radio frequency magnetron sputtering method [1,2]. Co K-edge XAFS spectra were obtained in fluorescence mode at the beamline BL-9C of the Photon Factory, the High-Energy Accelerator Research Organization. The films were measured at room temperature. A Lytle detector with a Fe filter was used. The spectra were analyzed with the IFEFFIT ver.1.2.12 (Athena ver.0.8.061).

3 Results and Discussion

Figure 1 shows the XANES spectra at the Co K-edge of a typical Co-Pd-Si-O nanogranular film and Co-Nb-O films. The spectrum of reference metallic Co has a small white line at ~7720 eV and a large pre-edge shoulder at ~7710 eV, while the spectra of reference Co₃O₄ and CoO have large white lines and small pre-edge peaks. Compared with those spectra of references, the spectrum of the Co-Pd-Si-O nanogranular film is close to that of metallic Co. This probably indicates that Co in the Co-Pd-Si-O nanogranular film is almost metallic. On the other

hand, the spectra of the Co-Nb-O are divided into three types. This clearly shows that there are three chemical states in the Co-Nb-O nanogranular films. The first type of the spectrum is very similar to that of Co-Pd-Si-O. Thus, this type of the film is probably composed of metallic Co. The second type has large white line similar to the reference Co oxides. The third type shows intermediate spectra of the first and second types. Therefore, the three types observed in the Co-Nb-O films probably correspond to the metallic, oxidized, and intermediate states of the Co-Nb-O nanogranular films.

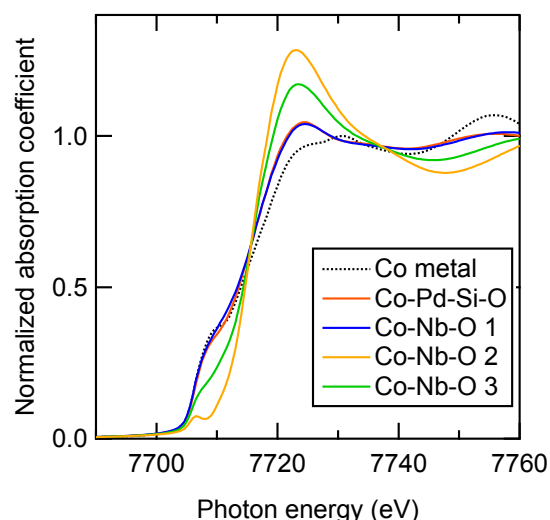


Fig. 1: XANES spectra of the Co-Pd-Si-O film and the Co-Nb-O films.

Acknowledgement (option)

We thank PF staffs for their help with experiment. This work was supported by JSPS KAKENHI Grant Number 22604003.

References

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