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Imaging of NiO(100) surface by SR-PEEM with linear dichroism in total yield spectrum near O *K*-edge

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Introduction

Photoelectron emission microscopy with synchrotron radiation (SR-PEEM) is a new powerful technique to investigate spatial anisotropy in electronic or magnetic structure of materials in an element specific way. Recently, this method allows us to observe anti-ferromagnetic (AF) domain structure of NiO(100) surface [1]. The domain is visualized by using magnetic linear dichroism (MLD) near the Ni *L*-edge, although MLD is never observed in conventional total yield spectrum for NiO crystal because of the isotropic coexistence of 12 AF domains. This means that SR-PEEM is very useful for detection of (M)LD signals. In this study, we have performed imaging of NiO(100) surface by SR-PEEM using linearly polarized light with photon energies near O *K*-edge. We found that LD exists near O *K*-edge.

Experimental

The PEEM experiments were performed on the beamline 2C and 13C at PF in KEK. Our system consists of three chambers (load lock, preparation and PEEM measurement chambers). The preparation chamber is equipped with an evaporator, an Auger electron spectroscopy system. The measurement chamber is equipped with PEEM (Staib PM350), Hg lamp, He discharge lamp, manipulator with liquid helium cryostat, and inlet for synchrotron radiation. All system is mounted on an air-damper to prevent any vibration from the experimental floor. The linearly polarized soft x-ray light was injected to the sample at about 70 degrees from the sample surface normal. NiO crystal was cleaved *in situ* in the UHV chamber.

Results and Discussion

Left and right panels in Fig. 1 show the total yield spectra of cleaved NiO(100) surface near O *K*-edge and Ni *L*-edge, respectively. Fig. 2(a) shows the PEEM image measured with the photon energy at the peak ‘a’ ($h\nu$ = 528.3 eV) in Fig. 1 divided by that at the peak ‘c’ ($h\nu$ = 536.8 eV). The dividing procedure enhances the contrast observed in original image. The pattern of contrast in Fig. 2(a) corresponds to that of AF domain image in Fig. 2(b) obtained by the dividing procedure with the photon energies at the double peaks ‘f’ and ‘g’ near Ni L_2-edge in Fig. 1, although the contrast is a half of Fig. 2(b). Thus, the intensity of image in Fig. 2(a) can be directly related to the AF ordering. A very weak contrast is also visible in the original image measured with photon energy at peak ‘a’. The best contrast enhancement is achieved for peak pairs of ‘a-c’ and ‘a-b’, not for ‘a-e’. These results clearly indicates that the existence of linear dichroism near O *K*-edge. According to the results of a first principle cluster calculation, peak ‘a’ arises from O 2*p* component interacting mainly with Ni 3*d* component [2]. Therefore, the peak ‘a’ shows the anisotropic nature corresponding to the magnetic moment of Ni atoms. The other peaks in left panel of Fig.1 show the isotropic nature, because these peaks are coupled mainly with Ni 4*p* or 4*s* components. This is the reason why the magnetic domain image is obtained by peak ‘a’.

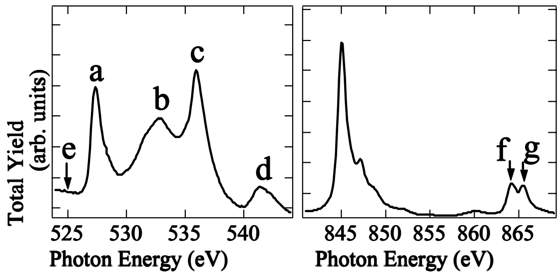

FIG. 1. Total yield specta of a NiO(100) surface near O*K*-edge (left) and Ni *L*-edge (right), respectively.

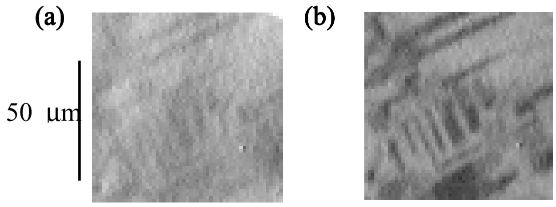

FIG. 2. (a) PEEM image of a NiO(100) surface measured with photon energy at peak ‘a’ in Fig. 1 divided by that with photon energy at peak ‘c’. (b) AF domain image of the same region obtained by dividing procedure with photon energies at peaks ‘f’ and ‘g’ in Fig. 1.

References

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