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Antiferromagnetic domain imaging of NiO(100) by PEEM & non-magnetic linear dichroism at O *K* edge: Essential effect of the antiferromagnetic crystal distortion

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Introduction

NiO is known to be a typical anti-ferromagnetic (AFM) material (Néel temperature T_N=523K). The crystal structure is slightly deformed to a rhombohedral contraction from the original cubic rocksalt structure along one of the four <111> axes below T_N. Due to the contraction, the crystallographic twinning leads to four different possible domains, so-called *T(win)*-domains, with different contraction <111> axes. Each *T*-domain has an easy axis along one of three [211]-derived direction and split into three different *S(pin)*-domains. Photoelectron emission microscopy (PEEM) with synchrotron radiation light (SR-PEEM) has been used for the study of the AFM domain structure of cleaved NiO(100) surface combined with magnetic linear dichroism (MLD) at Ni L_2 edge [1]. In the previous report [2], we reported the AFM domain imaging of NiO(100) by SR-PEEM using linearly polarized light around O *K* edge. The result was unexpected and unordinary, because the O atom should not have any magnetic moment. We concluded that the origin of the unexpected LD is caused from the strong interaction between the O 2*p* components with the Ni 3*d* components. However, it was not clear whether the crystal distortion effect is essential to the non-magnetic LD or not. In this report, we discuss the origin of the dichroism at O *K* edge based on the effect after deposition of magnetic metal films.

Results and Discussion

All the experiments were performed in the same way as in the previous report [2]. We connected our PEEM system to the BL-2C and 11A. In order to observe the effect of the metal deposition on to the NiO substrate, we prepared the wedge-shaped Fe film system whose thickness is from 0 to 30ML (monolayer). If the twinned structure of crystal is essential for the observation of the domain at O *K* edge, the observed image should not be affected by the deposition because the distortion may not be affected by the deposition so much. In contrast, the observed domain image at the Ni L_2 edge may be affected easily by the metal deposition.

Figure (a) shows the domain structure for the Fe/NiO system obtained at Ni L_2 edge in 3~5ML deposition region. In the same manner, the domain structure obtained for the same surface but O *K* edge is shown in Fig. (b). In Figs. (c) and (d), the same images but for the ~10ML region are shown. In the lower coverage region in (a) and (b), the domain pattern is not so different each other. However, in the higher coverage region, the domain pattern obtained at Ni L_2 edge (c) is strongly affected and almost disappeared whereas the clear image is obtained at O *K* edge (d). This phenomenon is the evidence that the AFM domain structure observed at O *K* edge reflects the *T*-domain and the crystal distortion effect is essential for the observed image.

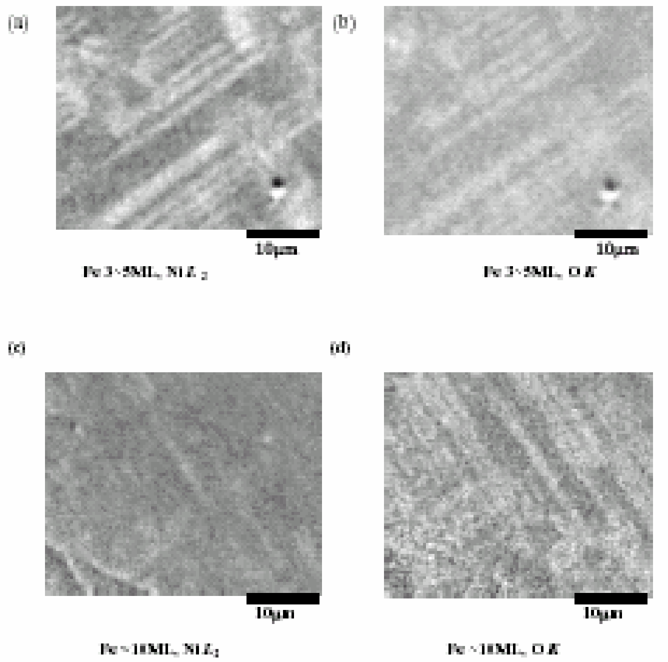

Figure
AFM domain images of the wedge shaped Fe covered surface of NiO(100). **(a)** Image at Fe 3~5 ML region observed at Ni L_2 edge. Two images at 870.2 eV and 871.5 eV are divided each other to obtain the clear AFM domain contrast. **(b)** Same as in (a) but at O *K* edge (528.3eV and 537.0eV). **(c)** Same as in (a) but at Fe ~10 ML region. **(d)** Same as in (c), but at O *K* edge.

References

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