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A Development of a New EXPEEM System (3) - Chemical Mapping of TaOx

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Introduction

It is quite important to obtain the real time chemical imaging of the surface in order to understand the chemical processes accompanying the diffusion and the reaction between different phases. EXPEEM(Energy-filtered Photoemission Electron Microscopy) is a new spectromicroscopy which can visualize the surface chemical state and element distributions by selecting the kinetic energies of photoelectrons. Previously we reported the first EXPEEM image obtained by a Wien filter energy analyzer using a high energy X-ray emitted from a bending magnet.[1] In the previous work we could obtain elemental distribution in a μm order. In this work we tried to obtain a chemical distribution based on a different binding energy of core electrons.

Experimental

The details of EXPEEM instrument are described elsewhere.[1] In this work we used the 5th order higher harmonics emitted from an undulator at BL2A. The X-ray was monochromatized by a Ge(111) double crystal monochromator. The ejected photoelectrons were collected by a cathode objective lens and filtered by a Wien filter. In order to decrease the spherical aberrations we put an angle limiting aperture with a 25 μm opening. In addition, a narrower energy selecting slit than reported before[1] was used after the Wien filter to get a higher energy resolution(ΔE=1 eV). The sample was Ta sheet with 10 μm Au island deposited. The separation of Au islands was 25 μm. PEEM was measured using a Deuterium lamp(HAMAMATSU L1314). The sample was irradiated through a BaF_2 window.

Results and discussion

Fig. 1 shows the PEEM picture of Au on TaO_x during the heating process. At room temperature, Au was brighter than the rest because of the Ta surface was fully oxidized and the work function of Ta region was larger than that of Au. When the sample was heated up to 723 K, the Ta area became brighter than the Au area. Especially periphery of Au island was the brightest. The line profile of the gray scale across the Au island clearly indicates that the gray scale was almost constant in the Au region and the Ta region became brighter. The periphery was brighter than the rest. If the Ta region at the periphery was really bright, the oxygen was removed first from the peripheral region. But PEEM contrast often suffers from the geometrical effects.[2] We carried out the EXPEEM analyses on the same sample, using Ta $3d_{5/2}$ photoelectrons with 1 eV energy step. Figure 2 shows the EXPEEM image using different photoelectron kinetic energies. The Ta region including the periphery of Au island became brightest at the photon energy of 654 eV. This demonstrates that the bright periphery around the Au region arises not due to the chemical reason but due to the geometrical reason. EXPEEM is more sensitive to the chemical information.

[1] H. Yasufuku, Y. Ohminami, T. Tsutsumi, K. Asakura, M. Kato, Y. Sakai, Y. Kitajima, and Y. Iwasawa, *Chem.Lett.*, (8), 842-843 (2002);H. Yasufuku, Y. Ohminami, T. Tsutsumi, H. Niimi, N. Matsudaira, K. Asakura, M. Kato, Y. Sakai, Y. Kitajima, and Y. Iwasawa, *Jpn.J.Appl.Phys.* **43**, (11), 7682-7688 (2004).
[2] S. A. Nepjiko, N. N. Sedov, G. Schonhense, *J. Microscopy*, **203** 269-276 (2001).

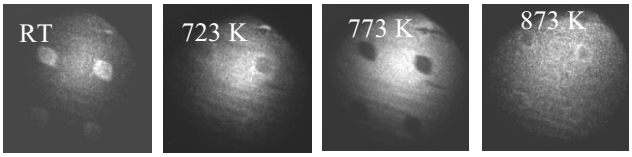

Fig. 1 PEEM picture of Au on Ta with different temperatures

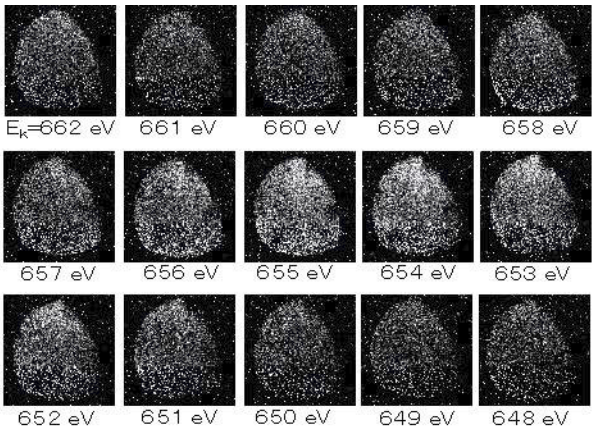

Figure 2 EXPEEM of Au on Ta measured with 1 eV energy step.

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