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Development of EXPEEM system

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Introduction

It is quite important to obtain the surface real time chemical imaging in order to understand the chemical processes accompanying the diffusion and 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] Here we will report the EXPEEM results of Au islands deposited on a Ta substrate using a higher intensity undulator beam line.

Experimental

The details of EXPEEM instrument are described elsewhere.[1,2] 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).

Results and discussion

Fig. 1 shows the principle of the Wien filter. Magnetic and electrostatic fields are perpendicularly applied on the electron passing through the Wien filter. As a result the electron which satisfies the Wien conditions ($\boldsymbol{E} = \boldsymbol{v} \times \boldsymbol{B}$), can go straightly through the Wien filter. Fig.2 shows the energy dispersion image of Au/Ta. The Au $3d_{5/2}$ and Ta $3p_{3/2}$ peaks appear bright on the image. When the energy selection slit was put after the Wien filter as shown in Fig.1b and the projection lens was adjusted to give real space image, we can get the energy-selected image as shown in Fig.3. In Fig.3a, the most electrons with their kinetic energy nearly 0 eV are due to Au $3d_{3/2}$ peak. Fig.3c shows a picture of the EXPEEM image using photoelectrons with their kinetic energy nearly 90 eV, corresponding to the Au $3d_{5/2}$ photoelectron peak. Both pictures gave brighter Au regions. On the other hand, the Wien filter was adjusted so that the photoelectrons with their kinetic energy = 102eV were allowed to arrive at the screen, the Au region became darker than the Ta region. By using the undulator as a photon source, we got much better EXPEEM images than at BL11B. We will soon apply the EXPEEM method to a catalytically active system.

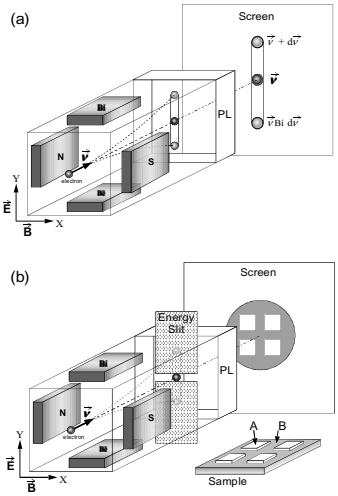

Fig.1 Wien filter and EXPEEM images.(a) Energy dispersive mode (b)Energy filtered image mode

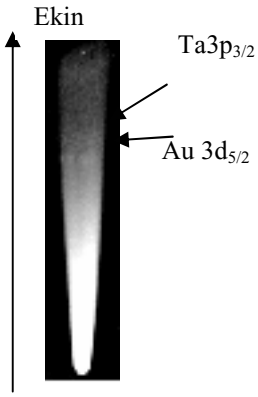

Fig.2 Picture for energy dispersive mode

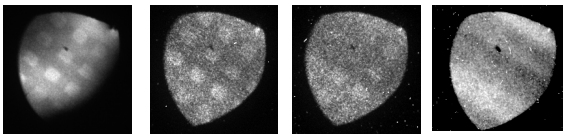

Fig.3 EXPEEM pictures of (a) Ek=0 eV,(b)50 eV(c) 90 eV(d) 102 eV

References

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