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Focusing of Soft X-ray for Quick PEEM Measurements

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Introduction

Photoelectron emission microscopy (PEEM) is recently developed powerful tool to observe surface of material at nanometer scale. In the previous study, we have developed a PEEM system combined with soft X-rays from synchrotron light source, and demonstrated that the method can be applied to the observation on chemical states at nanometer scale [1,2]. Generally, it takes minutes or seconds to observe an image of a static sample by PEEM. In order to observe fast phenomena such as surface diffusion and chemical reaction dynamics at solid surfaces, it is necessary to take a PEEM image in shorter time. For this purpose, we have to focus the X-rays on a small spot where PEEM images are taken. A poly-capillary lens is recently developed simple focusing tool for X-ray, proposed by Kumakhov et.al. [3] Here we present the results for quick PEEM measurements in the order of milli-second using poly-capillary lens.

Experimental

The experiments were performed at the BL-27A station. The PEEM system used was Elmitech Co. Model PEEMSPECTOR. The monochromatic X-rays passed through in the poly-capillary lens, and were focused on the sample position. The distance between the outlet of the lens and the sample was 300 mm. The samples investigated were micro-patterns of Si/SiO_2, Si/SiN_x and Si/Au. Organic compounds deposited on metal surfaces have also been investigated.

Results and discussion

Fig.1 displays PEEM images for Si/Au micropatterns exited by 3keV photons using poly-capillary lens. As shown in (C), only 10 msec is enough to take a clear PEEM image.

For Si/Au micro-pattern, we have measured the intensity ratio I/I_0 in soft X-ray region (1.8~4 keV), where I and I_0 are the brightness of a spot in the PEEM image with and without poly-capillary lens, respectively. A remarkable enhancement of the brightness is observed at 3 keV, where the I/I_0 value is about 50.

As an example of quick chemical-state mapping, the method can be applied to the observation of Si/SiO_2 micropattern. In fig.2(1) shows a PEEM image exited by 1846.6eV photons. The brightnesses of two domains shown as circles in the image (1) are plotted as a function of the photon energy. The results are shown in (2) and (3). The shapes of the plots (2) and (3) are similar to XANES spectra for Si and SiO_2 [1], respectively, so we can easily identify the valence states of the spots. In this way, we can obtain the XANES spectra in all domains in the PEEM image.

Thus the method will be applicable to identify time dependent phenomena (i.e. changes of chemical states, electronic structures, etc.) in the order of sec~msec at nanometer scale.

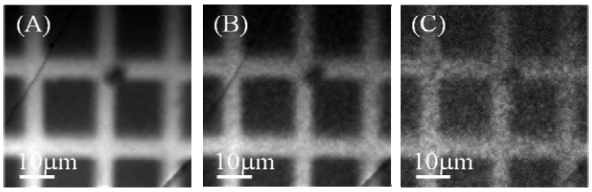

Fig.1 PEEM images of Si/Au micro-pattern excited by 3keV photons using poly-capillary lens.The measuring time is 1 sec (A), 100 msec (B), and 10 msec (C).

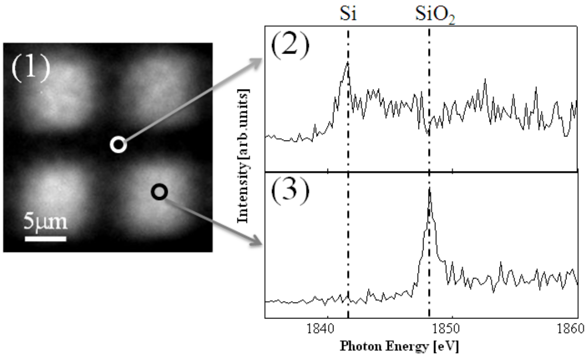

Fig.2 PEEM image of Si/SiO_2 micro-pattern excited by 1847keV photons using poly-capillary lens. The photon energy dependences of the brightnesses of the areas shown by arrows in the the picture (1) are plotted in (2) and (3).

References

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