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Focusing test of soft X-rays using poly-capillary lens for quick PEEM measurements

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Introduction

Photoelectron emission microscopy (PEEM) using synchrotron radiation is a powerful tool to identify chemical states, electronic structures, and molecular orientations at nanometer scale. In the previous study, we have developed PEEM system combined with synchrotron soft X-ray excitation in order to observe chemical state mapping of solid surfaces at nanometer scale [1,2].

Generally, it takes about 1 minute to observe an image for a static sample by PEEM using X-rays from bending magnet. In order to observe fast phenomena such as diffusion, dynamics and chemical reaction 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 is recently developed simple focusing lens for X-ray, and it was first proposed by Kumakhov et.al. [3] The poly-capillary consists of a bundle of thousands or millions of glass capillaries, and the X-rays in the capillaries are totally reflected from the internal surface of the tubes. The most excellent property of a poly-capillary lens is that the focusing point does not change with the photon energy, so it is suitable for the XAFS measurements. In this report, we present the result for the focusing test using a poly-capillary lens for quick PEEM measurements.

Experimental

The experiments were performed at the BL-27A station. The PEEM system used was Elmitech Co. Model PEEMSPECTOR. The samples investigated were Au-Si micro-patterns of 25 μm periodicity. The monochromatic X-rays impinged on a poly-capillary lens, and were focused on the sample position. The distance between the outlet of the lens and the sample was 300 mm.

Results and discussion

Fig.1 shows the PEEM images excited by various photon energies. The intensity ratios (I/I_0) are shown in the right side of the images, where I and I_0 are the brightnesses in the region A with and without poly-capillary lens, respectively.

A remarkable enhancement of the brightness is observed at 2 keV, where I/I_0 is about 38. In the previous work [1,2], we needed 1 minute to take a PEEM image and 1 hour to measure micro-NEXAFS spectra without poly-capillary lens. On the basis of the images shown in Fig.1, the measuring time is appreciably reduced. Only one second is enough to take a PEEM image, and a few minutes are needed to measure micro-NEXAFS spectra. So, our PEEM system using focused X-rays with poly-capillary lens will offer a promising prospect for observing fast phenomena in the order of milli-second.

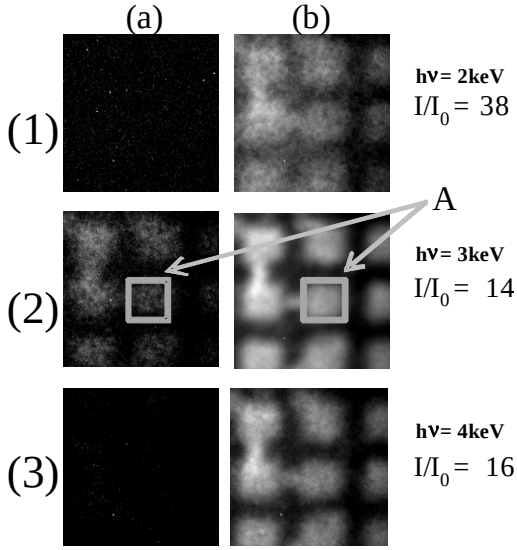

Fig. 1 PEEM images exited by 2keV (1), 3keV (2) and 4KeV (3) photons for si-Au micro-pattern. Colums (a) and (b) show images without and with poly-capillary lens, respectively.

References

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