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Nano-scale elemental analysis by synchrotron-radiation STM

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1 Introduction

We have developed nano chemical analysis system based on scanning tunneling microscopy (STM) combined with synchrotron radiation light source [1-5]. Upon irradiation of soft x-ray onto the sample, electrons are emitted from the surface whose amount depends strongly on the photon energy and elements on the surface. By locally detecting the emitted electrons with a probe tip of STM under photo irradiation whose energy is around the absorption-edge of a specific element, we have obtained spatial mapping of the element over the surface in high spatial resolution [3, 4].

For reliable measurements, it is necessary to establish the mechanism of the nano-scale chemical analysis technique. Based on the results taken so far, we presume that preferential detection of locally emitted secondary electrons by the tip because of the tip-induced reduction of the local work function below the tip. In order to elucidate the mechanism, we have investigated the detection efficiency and signal-to-noise ratio (SNR) of the photo-induced current under various experimental conditions.

2 Experiment

Experiments have been performed by attaching a home-made STM to a high performance soft-x-ray beam line, BL-13A, in KEK. As a sample we used Co islands formed on a Cu(111) substrate. After elaborately adjusting the beam position so that the x-ray is injected onto a sample surface just below the tip, we set the photon energy at 780 eV, the adsorption edge of Co 2p, and detected the photo-induced current with the tip to obtain its spatial distribution during the scanning of the tip over the sample surface. In order to improve SNR, we modulated the injected light with a chopper and detected the synchronized signal with a lock-in amplifier. As a probe tip, we used W tips coated with RF-sputtered SiO_2 thin film except on the tip apex in order to block electrons impinging to the side of the tip.

3 Results and Discussion

We have obtained local absorption spectra using an STM tip as shown in Fig. 1, and spatial distribution of Co element over the surface in nano-meter scale spatial resolution (Fig. 2).

We are analyzing the results to elucidate the mechanism of the analytical phenomena.

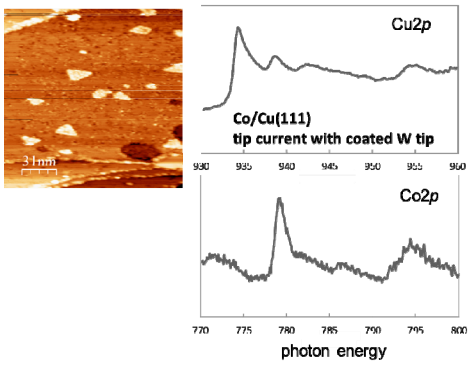

Fig. 1: (left) STM image taken on Co/Cu(111) surface. (right) absorption spectra taken at Cu 2*p* and Co 2*p* adsorption edges using an STM probe tip.

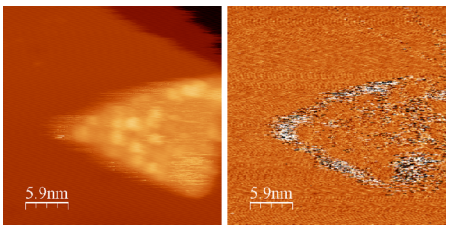

Fig. 2: (left) STM image of a Co island. (right) photo-induced current mapping taken simultaneously with a photon energy of 780 eV.

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References

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