Reflectivity measurements at vacuum ultra-violet using BL-1

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1. Introduction

Vacuum ultra violet (VUV) lights that have photon energies from several eV to several ten eV are used to analyze characteristics and electronic states of materials. Fabrication technique with VUV is interesting in photo-induced chemical reaction and lithography because VUV lights exert strong effects to chemical products and biological cells. At VUV beamline, experimental equipment as photoelectron spectroscopy, VUV irradiation and reflectivity were constructed. The beamline has photoelectron spectroscopy system at a main port (port A). It has also a free port (port B) to connect experimental equipment [1]. In this work, we constructed an improved reflection spectroscopy system. We also measured reflectivity of solid materials.

2. Experimental

A monochromatic VUV light was made by a direct incident monochrometer. The VUV beamline was constructed by pre-focusing mirror, 1m Seya-Namioka monochrometer, post-focusing mirror, and end station. A SR light is introduced to monochrometer using pre-focusing mirror. The Seya-Namioka type monochrometer makes monochromatic VUV light using a grating which is selected from three gratings. The post-focusing mirror focuses the monochromatic light. The energy range is from 5 eV to 50 eV, the energy resolution E/ΔE is 600. VUV reflectance spectroscopy system was installed on optical path between monochrometer and photoelectron spectroscopy chamber. Figure 1 shows the outline of optical path. The reflectance spectroscopy system has simple structure. The focused light is passed a circle slit. The focused light is passed a circle slit at after the post-focusing mirror. The VUV light is reflected by sample surface. After that, the reflected light is detected by photodiode (IRD, AXUV-100). The reflection angle at a sample surface is about

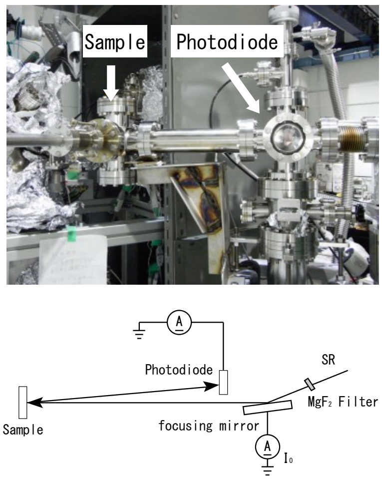

Fig. 1. A photograph and a schematic image of reflectivity measurement system.

two degree that satisfies Kramars-Kronig relation. The incident light intensity is detected by absorption current of post-focusing mirror. The incident light intensity is calculated using translation coefficient between mirror current and photodiode. The translation coefficient was measured the relation between mirror current and photodiode output since the photodiode value corresponding to incident light intensity cannot detect at the same time. A sample is held on a sample holder that connects on rotary/liner motion feedthrough. Some samples which are held on a sample holder can be measured in a pumping to vacuum. The reflection angle is adjusted so that the reflection intensity becomes maximum by rotation of the motion feedthrough. An MgF_2 filter can be inserted to cutoff the higher order light when the energy is less than 12 eV. VUV reflectance spectroscopies of some samples were carried out to demonstrations. The energy range is from 5 eV to 50 eV, the sweep step is 0.1 eV. The grating for middle energy range, Blaze wavelength is 96 nm, was used.

3. Result and Discussion

Figure 2 shows the reflectivity of a deposited gold on mirror polished SiO_2 (left), a native oxide SiO_2 on Si wafer (center), and a polyimide film (right). In lower energy than about 10 eV and higher energy than about 40 eV, the diffraction efficiency becomes low since the grating for middle energy range was used. The reflectivity shows characteristic peaks as each material [2, 3]. However, the reflectance values show lower than reported one. One of the reasons is that the surfaces were not clean since they were only mechanical polished. Other reason is that a high order light was included in the monochromatic VUV light. The reflectivity becomes low because the high order light was cut off at reflection on sample surface. However, in the VUV region, there is no filter for cutting high order light. We are considering how to prevent the high order light.

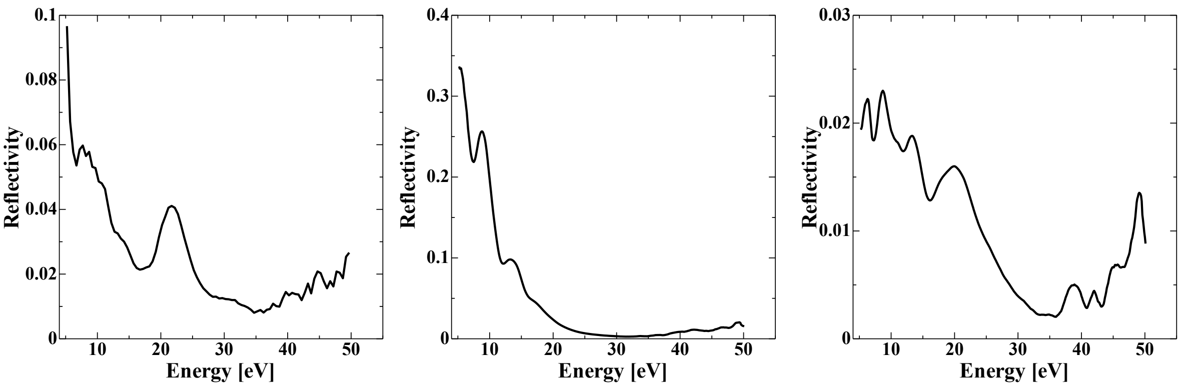

Fig. 2. Reflectance spectra of Au on SiO_2 (left), SiO_2 on Si (center), Polyimide film (right).

References

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