BL03XU
Advanced Softmaterial

1. Introduction

BL03XU is managed and operated by an industrial and academic joint organization FSBL(Advanced-Softmaterial Beamline), an advanced soft material beamline consortium, and dedicated to the "production" use on soft matter development. The main methods performed at BL03XU are small-angle X-ray scattering (SAXS), wide-angle X-ray scattering (WAXS), ultrasmall-angle X-ray scattering (USAXS), μ-beam SAXS/WAXS, grazing-incident SAXS/WAXS (GI-SAXS/WAXS), and X-ray photon correlation spectroscopy (XPCS). We can also perform simultaneous SAXS/WAXS measurements, the quick switching of the camera distance between 0.2 and 4 m, and experiments with a rather flexible setup. We try to reduce the switching time between experiments to increase the effective user beam time while enhancing throughput, as shown below.

2. μ-beam Apparatus

BL03XU enables us to perform μ-beam SAXS/WAXS measurements with beam diameters of 1 μm with a camera distance below 1 m and a wavelength of 0.12 nm, 4 μm with a camera distance below 3 m and a wavelength of 0.12 nm, and 10 μm with a camera distance below 3 m at any wavelength. For switching to a μ-beam, a set of optical instruments such as a Fresnel zone plate (FZP) and a refractive lens (CRL) had to be built with a considerable preparation time. This work required a BL adjustment time of about half a day. In addition, the optical devices are located in air or helium atmosphere, and the background due to scattering from the window material and air increased the unwanted noise level. Figure 1 shows a schematic diagram of the newly developed μ-beam chamber. The pinhole, which controls the size of the incident X-rays to the CRL, is adjusted using an automated XZ stage. CRL components can be selected for achieving the target size of the X-ray focus. The CRL can be retracted from the optical axis. The chamber is connected to the upstream and downstream components with vacuum pipes and kept at a low vacuum pressure of ~10 Pa. The temperature variation in the experimental hutch is maintained at about ±0.1°C to achieve high stability. Since the optical axis of the CRL does not change while the refractive lens is inserted, the realignment of the sample and SAXS camera is unnecessary. It is thus possible to switch layouts in about an hour even when changing the beam size between 1 μm and several hundred μm. Figure 2 shows a profile

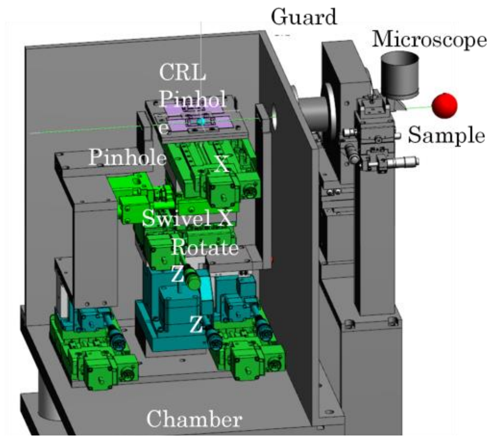

Fig. 1. Schematic diagram of devices in μ-beam chamber. A 1-μm-diameter μ-beam with a focusing distance of about 300 mm is used.

focused with the CRL at a focusing distance of 0.3 m. In the horizontal direction, the front-end slit is used as a virtual source. The vertical beam size was 1.3 μm in full width at half maximum (FWHM) with a flux of 1.3 x 10^{10} photons/s.

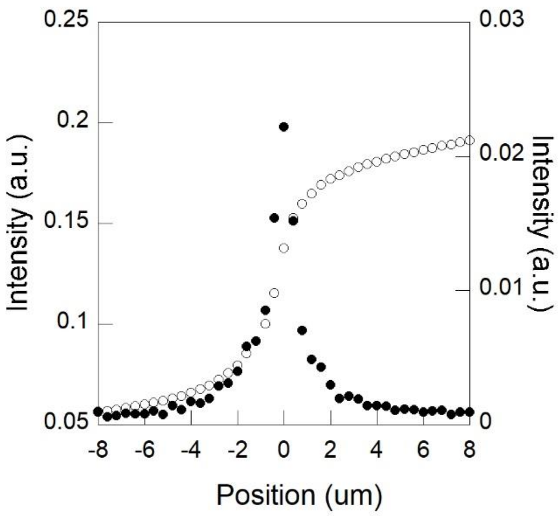

Fig. 2. Vertical beam profile at the sample position.

3. GI-SAXS/WAXS apparatus

The 1st experimental hutch (EH1) was originally designed for GI-SAXS/WAXS measurements (Fig. 3) for surface and thin-film structural characterization. However, the proportion of USAXS and XPCS measurements has recently been increased with the use of a μ-beam, and that of GI-SAXS/WAXS has been decreased to only a few percent of the user time. To achieve optimal operation, we decided to move the GI-SAXS setup to the second hutch where sufficient preparation time can be provided without disturbing the experiments conducted at EH1. The switching time of the hutch can be reduced from ~1 day to ~2 hours. For sample alignment, an X-ray intensity-reading beam stop (GIBS) for GI was incorporated into the existing beam stop chamber. Two sets of the 0.1-mm-wide slit were installed in the GIBS. A micro-scintillator and a photodiode are installed downstream of the slits to detect X-rays exiting the slits. Sample alignment is performed by measuring the transmitted X-ray intensity while changing the sample tilt and height. Depending on the distance between the sample and the GIBS, the sample angle can be adjusted with an accuracy of approximately 0.005 degrees or less.

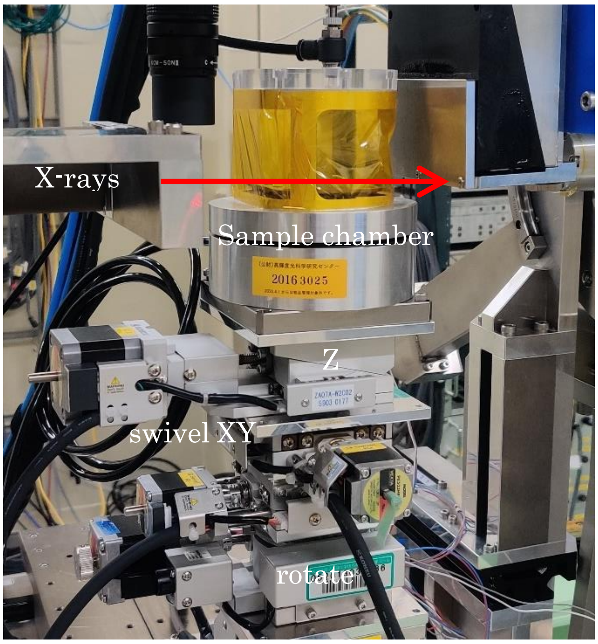

Fig. 3. Picture of goniometer for GI-SAXS/WAXS measurements.

Matsuno Shinya*[1], Takenaka Mikihito*[2], and Masunaga Hiroyasu*[3]

*[1] Representative of FSBL

*[2] Steering Committee Chair of FSBL

*[3] Japan Synchrotron Radiation Research Institute