BL40B2
SAXS BM

1. Introduction

BL40B2 beamline is used for the small-angle X-ray scattering (SAXS) measurements of soft materials such as proteins, synthetic polymers, and lipids. To improve user convenience, we have promoted the automation of the measurement system and upgraded the beamline systems with liquid chromatography. We are also developing other technologies to improve measurement accuracy and usefulness.

2. Upgrade of SAXS Measurement System with Liquid Chromatography

In 2021, a liquid chromatograph was introduced, making it possible to obtain size-separated flows from dissolved biological and synthetic polymers [1]. This chromatography system does not have an application for programming the interface function for setting or sharing measurement conditions. Therefore, a command set was created to control chromatography functions such as flow rate, column and sample selection, and sample volume, making it possible to easily use the chromatography system in conjunction with the beamline's SAXS measurement system. In particular, it has become possible to perform structural analysis in continuous flows over long periods of time, improving convenience.

The capillary flow cell for the SAXS system can be used in a vacuum (Fig. 1), which reduces the background of the scattering profile. The in-vacuum motion-drive mechanism allows the capillary irradiation position to be changed, improving the efficiency of optical alignment. If this flow cell is used for structural analysis, scattering information is expected to be easily detected even in samples with small electron density differences between the solvent and solute.

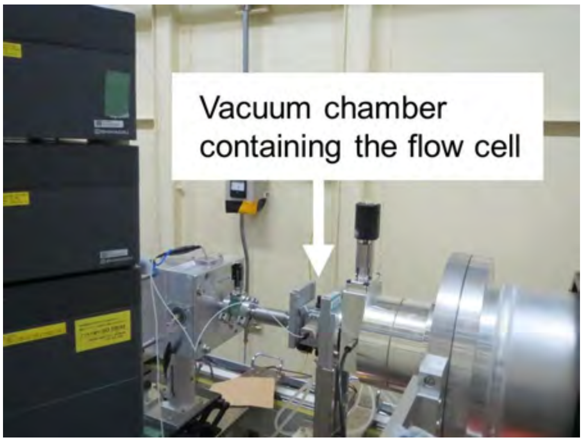

Fig. 1. Vacuum chamber containing the capillary flow cell is connected to a SAXS pipe. The capillary in vacuum is connected to a liquid chromatography system to perform low-background SAXS measurements.

3. Manual Wedge Wire Bonder for Beamstop

To promote the use of a photodiode-embedded beamstop, we have introduced a manual wedge wire bonder (Fig. 2). In experiments such as SAXS, the beamstop that absorbs the X-ray beam is placed just before a large-area 2D detector. By embedding a photodiode in the beamstop, it becomes possible to measure the intensity of the X-ray beam directly without using an ionized chamber. The photodiode requires electrical connections, and the image taken by the 2D detector will have a shadow of, for example, the wiring. If a thin metal wire is used, the shadow will be minimized. The beamstop is small, with a diameter of 3 mm, and the distance spanned by the thin wire is long, 150 mm, to match the large 2D detector, so manual connection is quite challenging. Therefore, we aim to reduce the technical challenges and make the wiring easier by using the manual wedge wire bonder.

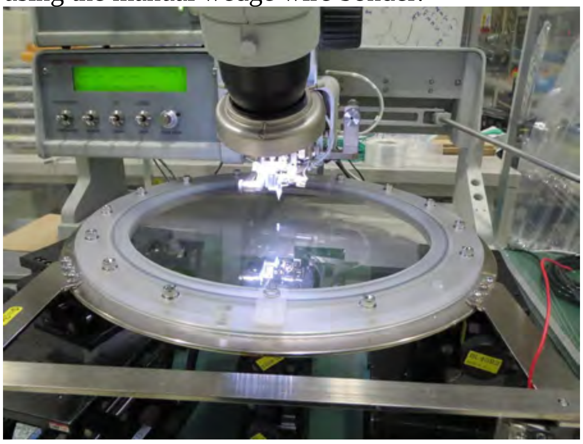

Fig. 2. Manual wedge wire bonder and a photodiode-embedded beamstop.

4. Precision Air Processor for Stabilizing Irradiation Position

A precision air processor was introduced to stabilize the X-ray irradiation position. Previously, the irradiation position would shift slightly due to temperature changes caused by opening or closing the door of the hutch. We surround the experiment table with strip-shaped curtains, allowing temperature-controlled air from the precision air conditioner to be blown onto the experiment table. This has improved the positional stability of the experiment table.

5. Upgrade of SAXS/WAXS Switching Measurement Setting

The WAXS vacuum chamber was installed in 2021 and is now widely used by users who want to quickly switch between SAXS and WAXS measurements [2]. Previously, it was possible to use it with SAXS camera lengths of 1.5, 2, 2.5, 3, 3.5, and 4 m, but it was not possible to use it with a camera length of 1 m. This was because the SAXS/WAXS chamber interfered with the SAXS vacuum pipe lift mechanism, making it impossible to connect the chamber and the pipe. By installing a new connecting pipe, the WAXS vacuum chamber can be connected to the SAXS pipe to allow the camera length of 1 m. The SAXS Q range can be expanded from Q_{max} = 5.2 nm^{-1} to Q_{max} = 7.8 nm^{-1} at a wavelength of 0.1 nm, allowing a wide range of configurations to suit the needs of users.

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References:

[1] Ohta, N. Gan, H. & Sekiguchi, H. (2022). *SPring-8/SACLA Annual Report FY2022*, 82.
[2] Ohta, N. & Sekiguchi, H. (2021). *SPring-8/SACLA Annual Report FY2021*, 74.