2 Newly Develped Experimental Systems

2-1 New Wide-Area Two-Dimensional Detector System for SAXS Experiments at BL-10C

The Photon Factory (PF) operates two small angle X-ray scattering (SAXS) beamlines, BL-10C and BL-15A, and partly uses BL-9C for SAXS. The beamtime management and beamline maintenance of BL-10C and BL-15A are performed in cooperation with user groups (the current chairpersons are Prof. Yoji Inoko of Osaka University and Prof. Mitsuhiro Hirai of Gunma University). Both beamlines have been operating for about 30 years, and the last major upgrades were done in the 1990s; thus, much of the hardware and software has become obsolete. However, SAXS activities have expanded year by year, and we have started upgrading the SAXS beamlines.

BL-10C was designed and constructed mainly to investigate non-crystalline materials such as aqueous solutions of biological macromolecules and synthetic polymers. Due to the low sample concentration and low-scattering contrast of such samples, a low-noise signal detection system is required, especially for higher-angle scattering data. For years, only a one-dimensional PSPC (RIGAKU) was used as a detector. In the summer of 2009, an imaging plate detector (R-AXIS 7, RIGAKU) equipped with a synchronized X-ray shutter was installed to measure wide-area two-dimensional scattering images (Fig. 1).

Preliminary experiments were performed using horse spleen apoferritin (Fig. 2). The X-ray wavelength, camera distance and exposure time were 0.1488 nm, 1980 mm and 600 sec, respectively. The BL-10C standard cell, which has a 1-mm beam path and a pair of 20-μm quartz windows, was used. The cell volume is 45 μl. It was held in a metallic cell holder to keep the sample at 24°C using a water-circulating pump. The various scattering data for different solutions were corrected by monitoring the beam intensities with an ionization chamber placed in front of the cell holder. Two-dimensional scattering data were circle-averaged around the beam center. The obtained signals were corrected for both solvent scattering and sample concentration to yield the net scattering intensity $I(q)$. The q-value was calibrated by the diffraction pattern of dried chicken collagen, and the observed q-range was between ~0.07 and 2.5 nm^{-1}.

Figure 2 shows a scattering curve for the horse spleen apoferritin. Apoferritin is a hollow-sphere molecule composed of 24 subunits and ~19,800 molecular weight. The scattering pattern indicates peaks at q = 0.8, 1.4, and about 1.9 nm^{-1}, and the resolution is sufficient for detailed structural characterization of the 24-mer

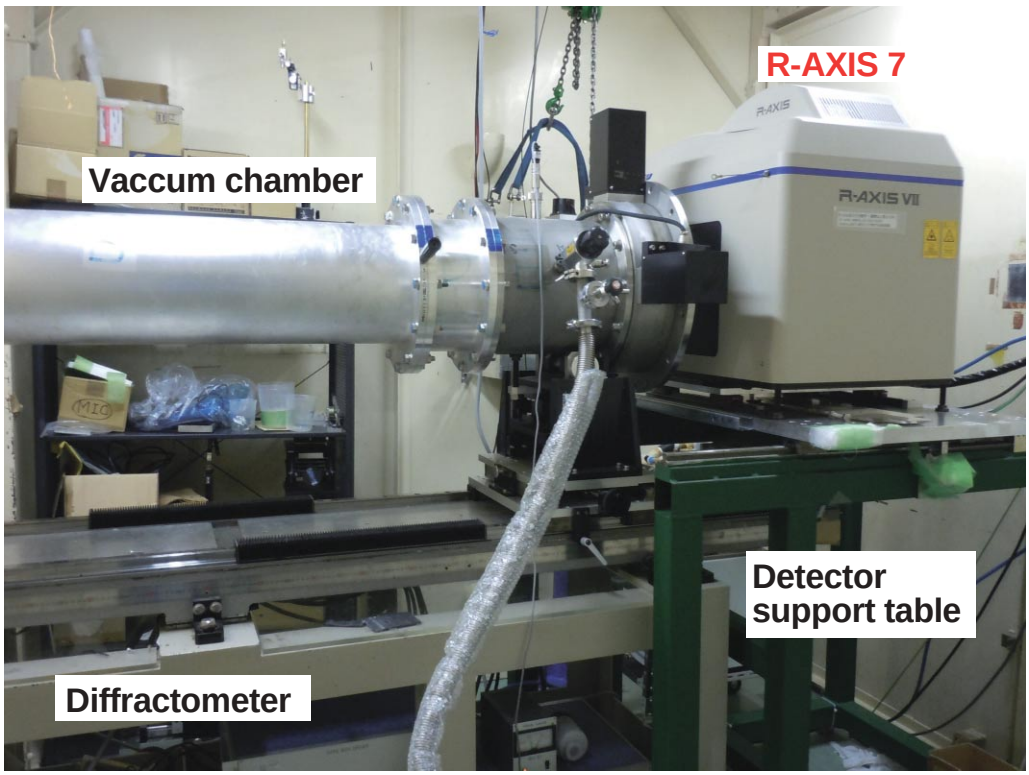

Figure 1
Long camera setting with a newly installed R-AXIS 7 at BL-10C.

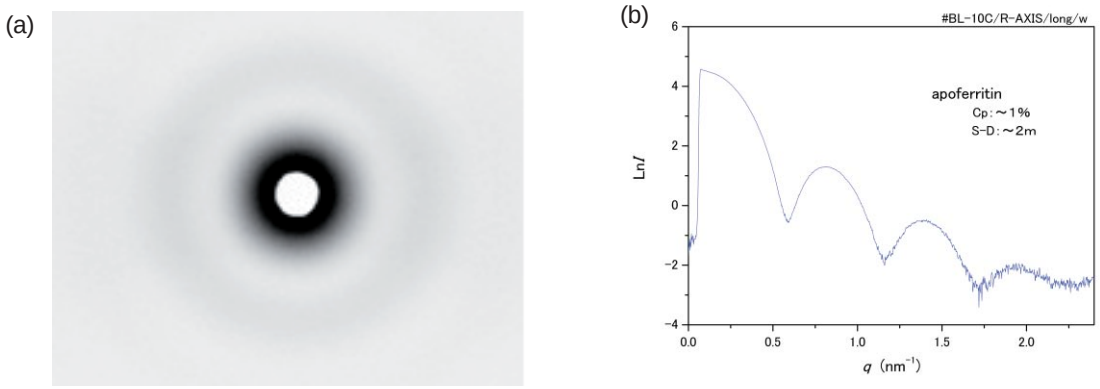

Figure 2
(a) Typical 2D pattern and (b) scattering curve (q vs. Ln*I*) of horse spleen apoferritin.

molecule. This result reveals the benefits of the new IP detector. All data were taken by Y. Watanabe of the National Food Research Institute, National Agriculture and Food Research Organization, Japan.

This R-AXIS 7 system was opened to users in April 2010. We are pursuing further upgrade programs for the SAXS beamlines. At the BL-10C, we renewed the interlock system and beamline safety components during the 2010 summer shutdown. A motorized size-forming slits system will be installed and the PSPC electronics will be changed from CAMAC to a high-speed data acquisition system based on Si-TCP technology [1].

REFERENCE

[1] T. Uchida and M.Tanaka, *IEEE Nuclear Science Symposium Conference Record* (2006) 1411.