BL08B2
Hyogo BM

1. Overview of BL08B2

Beamline BL08B2 at SPring-8 is a synchrotron radiation experimental facility managed and operated by the Hyogo Prefectural Government Office. This beamline provides various experimental techniques to industrial users, including X-ray absorption fine structure (XAFS), X-ray imaging, X-ray computed tomography (X-ray CT), and small-angle X-ray scattering (SAXS). The experimental stations for XAFS and SAXS are equipped with an automated sample exchange system designed to enhance the efficiency of sample measurements, including in situ observation experiments, enabling the collection of big data.

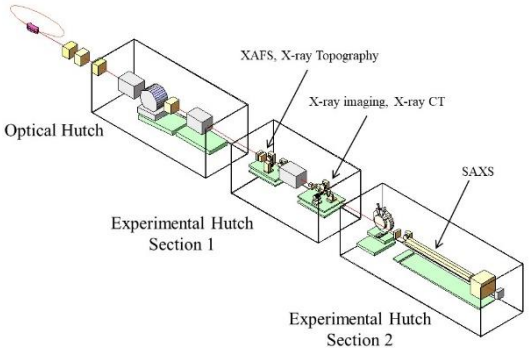

Fig. 1. Schematic layout of BL08B2.

In FY2022, user access to the X-ray CT, X-ray imaging, and SAXS experimental stations was facilitated in collaboration with the Japan Synchrotron Radiation Research Institute (JASRI).

2. Utilization status of the beamline by industrial sectors

Many industrial sector users make use of this beamline, with the highest utilization being in the field of engineering materials (34%), followed by batteries (22%), food industry (17%), and semiconductor materials (5%) (Fig. 2).

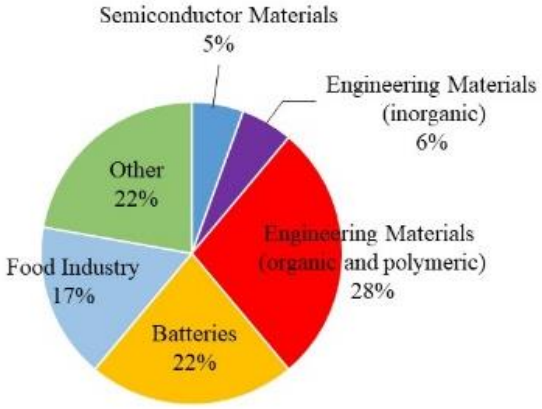

Fig. 2. Utilization percentages of BL08B2 by industrial sectors in FY2022.

In each industrial process, there is a high demand for elucidating micro/nanostructures of materials during the process. This is evident from the utilization rates of the various experimental techniques presented in Fig. 3, where SAXS stands out with an overwhelmingly dominant utilization rate. In SAXS experiments, both static and dynamic experiments are conducted extensively.

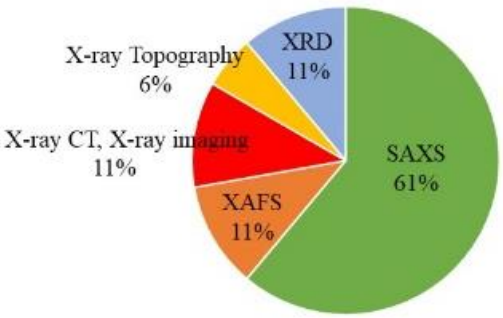

Fig. 3. Utilization percentages of each experimental technique at BL08B2.

3. Initiative towards integration of synchrotron radiation analysis and data science at BL08B2

An emerging trend in recent industrial utilization of synchrotron radiation is to use data science techniques for data analysis, specifically focusing on extracting maximum structural information about materials from the data generated in experiments. In this context, data on micro/nanostructures obtained through experiments with synchrotron radiation, particularly methods for observing dynamic structural changes, prove to be powerful tools effective for the research and development of unknown materials, as well as for improving processes related to products. To respond to this situation, fundamental research in data analysis technology utilizing Bayesian inference has been initiated, and as a starting point, efforts are being made towards the practical application of an analysis application for spectral data.

4. Examples of research in the food industry: retrogradation behavior and in situ observation of cooked rice grains preserved at low temperatures

It is well known that cooked rice ages, developing a harder and drier texture with time after it is cooked. Processed foods with cooked rice, such as rice balls and boxed lunches, are major industrial products, and methods for controlling their retrogradation is an important social issue. The retrogradation of cooked rice is partly due to the recrystallization of starch in gelatinized cooked rice, but many things remain to be clarified about its retrogradation mechanism. What makes it difficult to understand the mechanism is the differences between individual rice grains. On this occasion, a sealed sample changer suitable for the content of the experiment was originally developed by the user conducting this research. This device is equipped with a temperature control function in order to continuously track how individual rice grains change over time. Specifically, individual rice grains were analyzed by simultaneously conducting small-angle scattering and wide-angle X-ray diffraction measurements (WAXD), with the aims of observing their Å to 100 nm microscopic structure and clarifying how that structure changes with retrogradation.

Several types of cooked rice were used as samples. The crystallization behavior was analyzed by simultaneously conducting SAXS and WAXD measurements (Fig. 4). With the multi-rice grain thermostat, the temperature of the sample was well defined, and freshly cooked rice grains were set in separate sample cells that were then sealed. The area around the center of each rice grain was measured at intervals of 30 minutes for 36 hours. As a result, it was demonstrated that the observation of micro/nanostructural changes is possible.

Fig. 4. Experimental setup for SAXS and WAXD simultaneous measurement.

We are now in the process of verifying how different types of rice exhibit different retrogradation processes by analyzing how crystallization due to retrogradation advances using crystallization kinetics analysis. Powerful synchrotron radiation will be effective in extracting parameters that characterize product functions and then developing products based on findings from these analyses in the future.

Regarding the operation of the experimental stations for user access, we would like to express our gratitude for the cooperation of JASRI.

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