New Concept for a Synchrotron Radiation Diffractometer

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If several kinds of experiments are carried out in turn with their own apparatus in an experimental hutch on shares, one will take a hard time to replace, orient and adjust the apparatus. It is important to avoid such a replacement. This requires a versatility on the apparatus.

In advance to instrumentations in the SPring-8 experimental hall, we had a chance to manufacture a diffractometer to be used in the radioisotope (RI) experimental area at the Photon Factory (PF-KEK) established by a joint group of the Japan Atomic Energy Research Institute (JAERI) and PF-KEK. It was originally designed by JAERI, since the limited area could not accommodate bulky apparatuses, and compact and adaptable experimental machines were required to be installed. The machine had been planned to be used for extensive diffraction experiments on crystalline and amorphous samples containing actinide and other radioactive elements under various environments, such as high and low temperatures, high pressure, vacuum circumstances, magnetic field, etc. Its applicability was extended by providing three rotational and one translational stages in addition to the conventional six circles, 2θ, ω, χ, ϕ, $2\theta_a$ and ω_a. Those four stages were 1) $\chi_{2\theta}$ to lift up a detector from the equatorial plane of the Ewald sphere and 2) α to rotate the whole body of the goniometer on the horizontal table, 3) χ_a to rotate a crystal analyzer system about the diffracted beam direction and 4)Z_ϕ to remotely adjust the height of the ϕ table or the sample. The system can automatically be operated with 31 stepping motors, 2 ac servomotors and 2 solenoids with a computer remotely located outside the experimental hutch. Fig. 1 shows the whole system before the installation in the hutch.

A wide applicability was achieved by introducing the concept of the diffuse scattering measurement, that is, particularly from a feature of measuring the density of intensity distribution in reciprocal space. A viewed volume in reciprocal space is to be infinitesimally small at the high resolution extremity. Reduction of the sampling volume can be achieved by collimating the incident and diffracted beams with slits (including solar slits) and/or analyzing crystals.

This diffractometer is now being used for general diffractometry along with the performance tests. This machine will be commercially available from Kohzu Seiki Co., Ltd., Japan. Recently, an 8-axes diffractometer has become commercially available from Huber Diffraktionstechnik GMBH (Germany), which is named 'Psi Circle Diffractometer'. The so-called psi-scan measurement is a special case of the in-plane scattering measurement mentioned above with the 2θ angle fixed. The diffractometer has 8 independent axes and can also be used for the in-plane scatterings and other scans to a large degree of freedom. Our diffractometer was compacted so as to be accommodated in the radioisotope experimental area by mechanically coupling some of the angles at a cost of disadvantage of freedom. However, it has a much room for installing a cryostat on the χ circle and a strong arch for detector stage with the both sides supported. The latter enabled us to put the χ_a circle of the analyzer system for polarization analysis.

The floor plan of the RI facility in SPring-8 has been completed, into which three beamlines will be pulled. One of them will be used for X-ray diffractometry, and a similar multi-circle diffractometer will be installed.

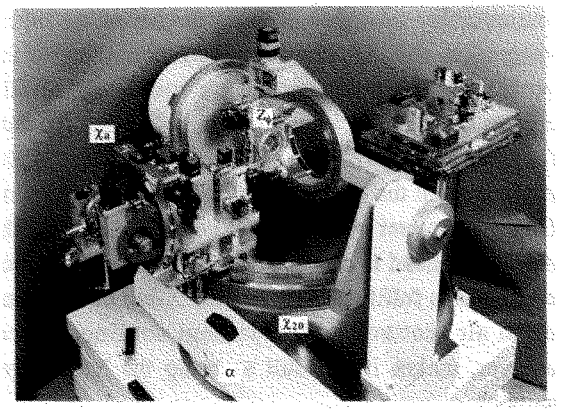

Fig. 1 New diffractometer on BL-27B at PF.