Quick X-Ray Reflectometry in Multiple Angle-Wavelength Dispersive Mode

Etsuo Arakawa[1], Tadashi Matsushita[2] and Yasuo Higashi[3]
1 Department of Physics, Tokyo Gakugei University, Koganei, Tokyo, Japan
2 Photon Factory, Institute of Materials Structure Science, High Energy Accelerator Research Organization, Tsukuba, Ibaraki, Japan
3 Engineering Center, High Energy Accelerator Research Organization, Tsukuba, Ibaraki, Japan

Toward time-resolved X-ray reflectometry on a time scale of sub-seconds to milliseconds, a simultaneous multiple angle-wavelength dispersive X-ray reflectometer is being developed. With this recflectometer a whole profile of interest of a specular X-ray reflectivity curve can be measured without any need for angle scanning of a specimen, a detector or a monochromator crystal during measurement.

To record reflected intensities simultaneously in the wide range of vertical momentum transfer ($q = 4\pi\sin\theta/\lambda$), we used a convergent X-ray beam with which the wavelength (λ) (energy (E)) and the glancing angle (θ) to the specimen surface change continuously at the same time as a function of direction. To realize such a convergent beam, we used a bent and twisted polychromator crystal. An inclined slit is placed upstream of the crystal, so that the footprint of the X-ray beam is along a line from the upper right to the lower left corners of the crystal. The crystal is elliptically bent within the horizontal plane and it also is twisted by a few degree around the cross line of the crystal surface and the horizontal plane. The beam reflected at the upper right corner is slightly deflected downward, while that at the lower left corner maintains the same vertical direction.

The specimen is horizontally located at the focus position. The wavelength (energy) and the glancing angle change continuously as a function of the X-ray path direction covering a wide range of q. One meter downstream of the specimen, the reflected intensity distribution is recorded using a pixel array detector (PILATUS-100K). By dividing this intensity distribution with that recorded without the specimen, a whole profile of reflectivity curve in a wide q-range is obtained.

The principle of the method and some results of a preliminary experiment will be reported in detail.