Quick X-Ray Reflectometry in Simultaneous Multiple Angle-Wavelength Dispersive Mode for Time-Resolved Measurements

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Our group is developing a simultaneous multiple angle-wavelength dispersive X-ray reflectometer for time-resolved X-ray reflectometry on a time scale of sub-seconds to milliseconds. As shown in Fig. 1, a bent and twisted crystal polychromator produces a convergent X-ray beam for which the wavelength λ (energy E), the glancing angle θ to the specimen surface, and the X-ray intensity change continuously as a function of direction .The specimen is located horizontally at the focus position. One meter downstream of the specimen, the reflected intensity distribution is recorded using a two-dimensional pixel array detector (PILATUS-100K). By dividing this intensity distribution with that recorded without the specimen, a whole profile of the specular X-ray reflectivity curve $R(q)$ is obtained simultaneously in the wide range of vertical momentum transfer $q = 4\pi\sin\theta/\lambda$.

The reflectivity curve of a Si (100) wafer specimen in the range of $q = \sim 0 - 0.45$ Å^{-1} was simultaneously measured with one exposure. With a sufficient exposure time (1000 s), the minimum measured reflectivity $R_{\min}$ was 1×10^{-8}. With shorter exposure times (0.01 ~ 1 s), $R_{\min}$ was of the order of $10^{-6} \sim 10^{-7}$. Results obtained for other specimens (a gold film on a silicon wafer, photo response molecules films on slide glass, the liquid surface of ethylene glycol) will also be reported. $R(q)$'s of the Si (100) wafer specimen and the gold film will be compared to results measured by the conventional angle scan method.

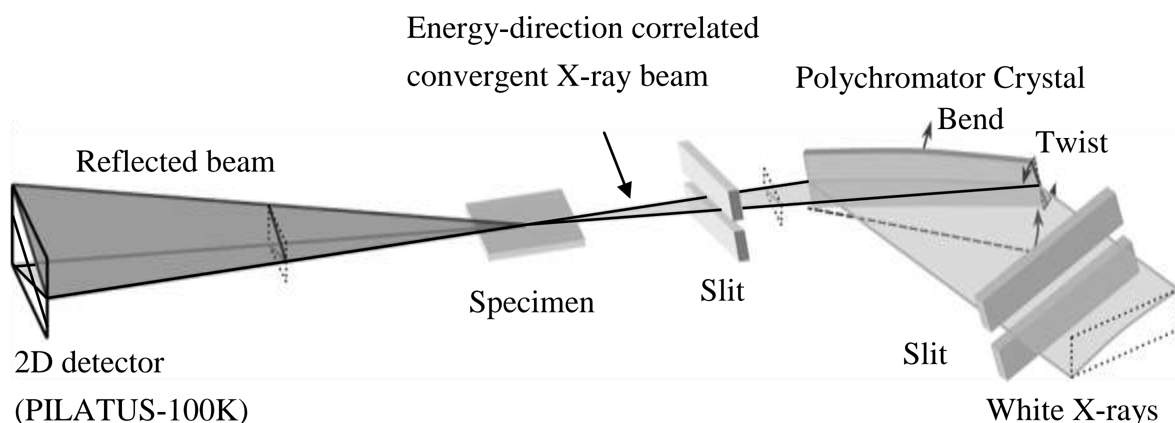

Fig. 1 A Schematic View of Quick X-Ray Reflectometry in Multiple Angle-Wavelength Dispersive Mode