ミリ秒時間分解能X線反射率法の開発
Development of an X-ray reflectivity method with millisecond time resolution

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Our group has developed a number of methods for fast measurement of the X-ray reflectivity (XRR) [1], crystal truncation rod scattering (CTR) and reciprocal space mapping [2]. Using these methods, structural changes of surfaces and thin films can be observed with a time resolution on the order of seconds or faster. They use an X-ray beam with a range of energies and directions to observe a large area in reciprocal space simultaneously. In this poster, we report on a new method for measuring the XRR curve with a time resolution in the millisecond range using a tapered undulator X-ray source.

The experimental setup is illustrated in Fig. 1. The new method uses the polychromator described in Ref. 2, which produces a horizontal fan-shaped convergent X-ray beam with a one-to-one correspondence between direction and X-ray energy (16-23 keV). The sample is placed at the focus with an angle of 45° to the horizontal. The reflected beam is observed with a 2D pixel array detector (Pilatus 100K). In this setup, the glancing angle θ_L of the low energy part (E_L) of the incident beam is small, while the glancing angle θ_H of the high energy part (E_H) is large. The reflectivity curve from $q_L=4\pi\sin\theta_L/\lambda_L$ *to* $q_H=4\pi\sin\theta_H/\lambda_H$ ($\lambda=12.398/E$) can therefore be observed simultaneously on the detector.

As a test sample, a 15 nm-thick gold film on silicon was used. With a measurement time of 10 ms, the reflectivity curve in the range from 0.03 to 0.3 Å^{-1} (minimum reflectivity ~10^{-6}) could be observed with a single exposure.

[1] T. Matsushita *et al.*, AIP Conf. Proc. 1234, 927-930 (2010).
[2] T. Matsushita *et al.*, J. Appl. Phys. 110, 102209 (2011).

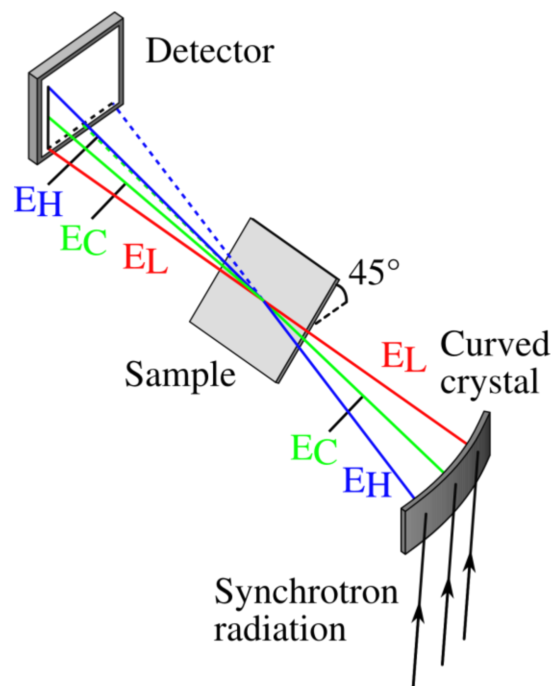

Fig. 1 Illustration of the new X-ray reflectivity method.