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Quick X-Ray Reflectometory in Simultaneous Multiwavelength Dispersive Mode

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Aiming for realization of time-resolved specular X-ray reflectivity measurement on the subsecond to millisecond timescales, a conceptually new method of measuring specular X-ray reflectivity curve is being developed.[1,2] The entire profile of the reflectivity curve of interest is simultaneously measured with the geometry shown in Figure 1. A horizontally convergent X-ray beam which has a one-to-one correlation between its direction and energy is realized when a quasi-parallel white X-ray beam is incident on and diffracted by a curved crystal (Si 111 reflection, 72 μm thick, radius of curvature: 10cm). The X-ray beam is then incident on the surface of the specimen placed at the focus in the geometry such that the glancing angle in the vertical direction is the same for all the X-ray components, and they are reflected in the vertical direction by the surface and diverge in the horizontal plane. The perpendicular momentum transfer, given by $q = 4\pi\sin\theta/\lambda$, continuously changes as a function of the horizontal ray direction even with the fixed glancing angle θ since the wavelength (energy) λ changes (from 8 keV to 40 keV). The X-ray intensity distribution across the beam direction measured downstream of the specimen using a one-dimensional detector (25.6 mm long fiber-optic coupled photodiode array (HAMAMATSU S3904-1024)) represents the X-ray reflectivity curve. Since the horizontal beam width was approximately 60 mm at the detector position, the spatial intensity distribution was measured at four horizontal positions of the detector, displaced by 15 mm across the direction of the central beam.

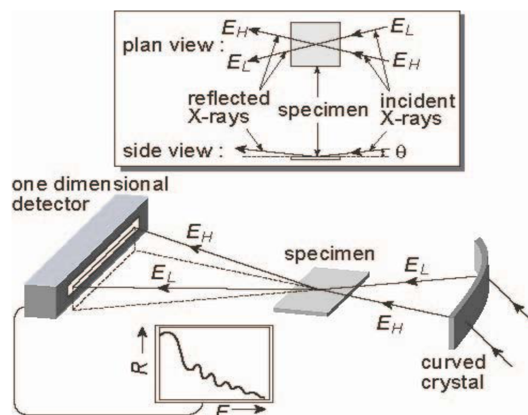

Fig.1 Geometry of simultaneous multiwavelength x-ray reflectometer

Figure 2 shows reflectivity curves from a 14.3 nm thick gold film on a silicon substrate as measured with exposure times of 2 ms to 1 s.

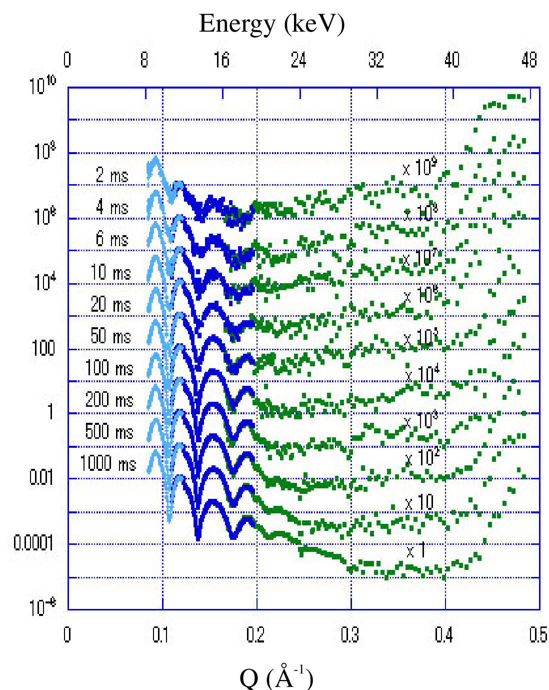

Fig.2 X-ray reflectivity curves as measured in 1 ms – 1 s.

References

[1] T. Matsushita, Y. Inada, Y. Niwa, M. Ishii, K. Sakurai, and M. Nomura, *Journal of Physics: Conference Series* **83,** 012021 (2007)

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