Depth-resolved monochromatic nanobeam X-ray diffraction for evaluation of local strain in single crystalline samples using differential aperture method

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Synchrotron nanobeam X-ray diffraction (nanoXRD) technique is a powerful technique that enables investigation of local strain in single crystalline thin films with spatial resolution around 100 nm. In case of thick samples, however, high-spatial-resolution is unavailable because penetration length of hard X-rays to samples is 10 to a few 10s of μm, that determines the spatial-resolution. Several methods have been developed for depth-resolved measurements; 3DXRD [1], deferential aperture [2], fitting of diffraction images [3] and tomography [4]. These methods are mainly used for polycrystalline samples. In this study, we applied the deferential aperture method to the monochromatic nanoXRD for depth-resolved evaluation of bulk single crystals and single crystalline thick films.

Platinum wire with a diameter of 100 μm was used as the deferential aperture. The wire was set close to the sample and scanned parallel to the surface. Figure 1(a) shows schematics of the sample and the wire scan method. Figure 1(b) shows diffraction intensity against the wire position. There are two dips; A~B is due to interception of incident X-rays and C~D is due to interception of diffractions. The position of D in Fig. 1(b) is the position where the only diffraction from the top surface is observed. Diffractions from deeper area are observed together when the wire scans to right side. By applying differential aperture method to the nanoXRD, we enabled XRD measurement with depth-resolution better than 1 μm. We will report evaluation of depth-resolution from geometrical condition and a recent result. [5]

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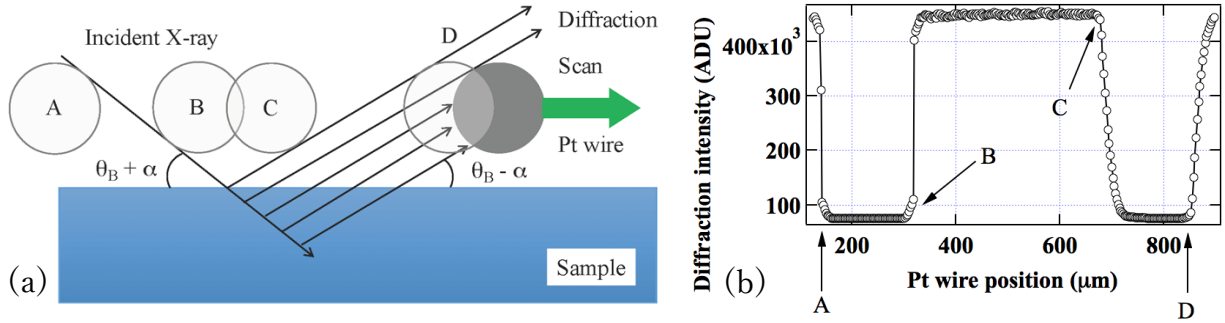

Fig. 1 (a) A schematics of the sample and the platinum wire intercepting the diffraction condition.
(b) Diffraction intensity profile with the wire scanning. The wire positions A~D shown in (a) correspond to those shown in (b).