in-situ Observation of the Domain Dynamics of Piezoelectric Films Under Applied Electric Field

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[Background]

PZT films have been investigated applicable for piezoelectric applications including microelectro-mechanical system (MEMS). Its characteristics are well known to be strongly related to the crystal structure and the domain structure of the films. However, the direct *in-situ* observation of the crystal structure and the domain dynamics under the electric field has been hardly reported. In the present study, we tried to this by using synchrotron XRD.

[Experimental]

1.5 μm-thick PZT films grown on (111)$SrRuO_3$//(111)$SrTiO_3$ substrates by MOCVD were used[1]. Pt top electrodes with 100 and 200 μmϕ in diameter were made by evaporation methods.

[Results and Discussion]

Figs.1 and 2 show the mapping data of the PZT *111* diffraction peaks and Pt Lα fluorescence of the samples. Positions of top electrodes were clearly detected. These data clearly show that positions of top electrodes can be detected for both methods. Moreover, we cannot fined any change on the θ–2θ profiles and the rocking curves of PZT *222* diffraction peaks at the top electrode positions where electric field was prior applied from 0 to 3 times of the coercive field.

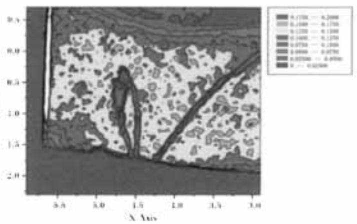

Fig.1 PZT *111* diffraction peaks mappings

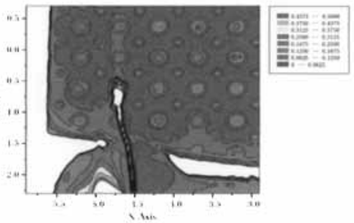

Fig.2 Pt Lα mappings

[References]

S.Yokoyama et al., Appl. Phys. Lett., **83** (2003)2408-2410.

Formation of nanocrystalline high-pressure phase of iron under femtosecond laser driven shock compression

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The lower pressure and temperature α phase of the bcc structure of iron transforms at higher temperatures to the γ phase of the fcc structure and at higher pressures to the ε phase of the hcp structure. A shock induced α ↔ ε phase transition in iron is one of the most famous transitions under high pressure. The quenched ε phase after shock unloading has not been observed, so that the shock-induced α – ε phase transition in iron has been considered diffusionless and completely reversible.

Sano *et al.* investigated the crystalline structures in a recovered iron sample which was irradiated by a femtosecond laser and confirmed the quenched ε and γ phases using electron backscatter diffraction pattern (EBSP) method [1]. However, evidence of X-ray diffraction is also required because the EBSP method is not recognized as the established method. We would like to use synchrotron X-ray to measure because a wide-use X-ray diffraction system could not detect the ε and γ phases. The purpose of this experiment is to obtain diffraction peaks of the ε and γ phases using the synchrotron X-ray.

Annealed polycrystalline iron (purity: 99.99 %) was used as a target sample. The femtosecond laser pulse (wavelength: 800 nm, pulse width: 120 fs, spot size: approximately 50 μm, pulse energy: 0.60 mJ/pulse, average intensity: 6.4×10^{13} W/cm^2, average fluence: 7.6 J/cm^2) was irradiated on the polished iron surface in the Ar atmosphere. The laser pulse was irradiated each 50 μm steps on the surface. X-ray diffraction measurements were performed using a six-circle diffractometer at beamline BL13XU for surface and interface structures, SPring-8. Photon energy 12.4 keV, wavelength 1 Å was used in this measurement. The incident angle was fixed at 1.0 deg and measurements were performed at 0.05 deg/step and 100 s/step out of the peak angles of α-Fe. Spectra for the detector angle of 30 – 34 is shown in FIG. 1. (a) shows the raw data measured and (b) shows the data from which the background is subtracted. Two peaks of ε-Fe (101) are found as shown in FIG. 1.

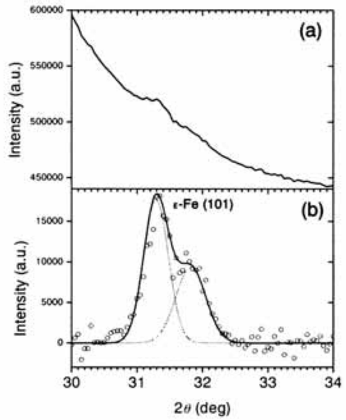

FIG. 1. Measured synchrotron X-ray diffraction spectra.

[1] T. Sano, H. Mori, E. Ohmura, and I. Miyamoto, Appl. Phys. Lett. 83, 3498 (2003).