X-Ray Diffraction Study on Ultra-Thin Barium Titanate Films GroWn by Reactive Evaporation

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Ferroelectirc thin films are extensively studied for use of capacitor in non-volatile memory devices. Many problems are now solving for mass production of mamory devices. On the other hand, growth mechanism and physical properties of ferroelectric thin films are also inetersting.

Barium titanate(BT) thin film on a strontium titanate(ST) substrate have been grown by reactive evaporation. [1] Single crystalline growth was confirmed by RHEED(Reflection High Energy Electron Diffraction) observation.

X-ray diffraction measurements were performed at BL02B1 with monochromatized radiation of 34.9keV(λ=0.355Å). The synchrotron was operated with the ring currnt of 20mA. Figure I shows the X-ray diffraction profile around strontium titanate(ST) 004 (2θ=20.896˚). Submaximum found at 2θ=19.6˚ is the Bragg reflection from 100Å-thick BT thin film. Around the peak, many satellite reflection can be found. These peaks come from the interference of X-rays which are reflected top and bottom of the film. From the satellite position, film thickness can be calculated as 78.8Å, that suggests that a part of thin film is not coherent. Many peaks means that the BT film has quite uniform thickness.

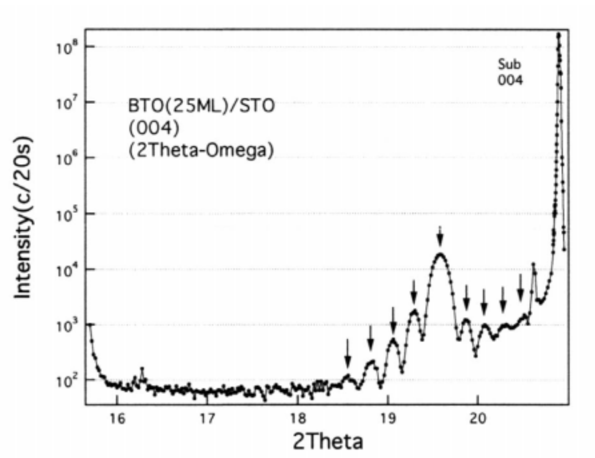

Figure 1 X-ray diffraction profile from 100Å-barium titanate thin film. Peaks from BT are indicated by arrows.

In point of evaluation of bamline, comparing between the laboratory system using 18kW rotating-anode-type generator with a Ge monochromator and a bent PG monochromator and BL02B1 is shown in Table I. So far as the intensity from substrate, in BL02B1, we are able to obtain 200~3000 times higher inetnsity than that in laboratory. However, for BT thin film, especially comparing with the case using bent monochromator, we can obatin only 7 times higher intensity. The mosaic spread of BT film was estimated as 0.1˚. This suggests that the inensity advantage for using BL02B1 strongly depends on the sample quality. This problem will be partially resolved when the ring operating with 100mA and grading-up the monochromator. But essentially, another optical devices, for example, graded monochromator which we have proposed, will be needed for the phase transition experiments.

References

[1] Y.Yoneda *et al.* :J. Cryst. Growth, 150 (1995)1090.
[2] K.Sakue *et al.*:SPring-8 Annual Rep. (1996) 65.

Table I Normalized peak intensity and background intensity comparison between laboratory and SPring-8 beamline. Monochromator is shown in parenthesis.

	ST 004	BT 004	Background
Lab(bent PG)	5×10^4	150	0.5
Lab(Ge)	3×10^3	2	0.1
SP8(Si)	1×10^7	1000	3.5