Structural analysis of ultra-high quality transparent conducting films

Hirokazu IZUMI* (3447), Takahiro KANEYOSHI (3464), Tsuguo ISHIHARA (3454), Hideki YOSHIOKA (3442), Hidenori KOHZUKI (3474), Hiroshi MATSUI (3462) and Muneyuki MOTOYAMA (3494)

Hyogo Prefectural Institute of Industrial Research, Yukihira-cho, Suma-ku, Kobe 654-0037, Japan

Indium tin oxide (ITO) film is used as a transparent electrode in many devices such as liquid crystal displays (LCDs) and solar cells because of its good opto-electronic properties. For application in colored large size LCDs, low temperature deposition of low resistivity films is desirable requirement. It is necessary to control of the microstructure and the lattice defect of the film precisely to achieve this requirement. In the present work, dependence of the crystal structure and electric properties on the preparation conditions was investigated.

ITO films were prepared on Si (100) substrate by pulsed laser deposition (PLD) method with a KrF excimer laser (λ=248nm) irradiation. Condition of the film deposition was shown in Table 1. Crystal structure of the films were analyzed by a grazing-incidence-angle x-ray diffraction with the x-ray surface analyzer at BL24XU in SPring-8. We can determine both out-of-plane and in-plane diffraction of the film because there are two SR-sample-detector arrangements, as shown in Fig. 1(a) and (b).

Figure 2 shows the grazing-incidence-angle x-ray diffraction patterns of the film. For the out-of-plane diffraction patterns (solid lines), splitting of the peaks was observed at the higher incident angle. However, the intensity of the peaks at the higher 2θ degree reduced with a decrease in the incident angle. This evidence has already been reported about ITO films prepared by sputtering or electron beam evaporation[1]. On the other hand, we found that no peak splitting occurred in the in-plane diffraction patterns (dashed line) of the films with increasing incident angle. This indicates that there are two layers in the film and the lattice spacings of the out-of-plane direction are elongated in the upper layer of the films.

[1] C.H.Yi, Y.Shigesato, I.Yasui and S.Takaki, *Jpn.J.Appl.Phys.*, **34**, L244 (1995).

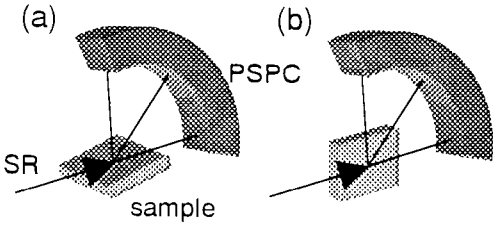

Fig.1 Illustration of SR-sample-detector arrangement (a) for out-of-plane and (b) in-plane diffraction measurement.

Table 1 Condition of ITO film preparation.

Laser	KrF(248nm), 150mJ, 20Hz
Target	In_2O_3-SnO_2 (90wt%-10wt%)
Atmosphere	1.0×10^{-2} Torr O_2
Thickness	~120nm

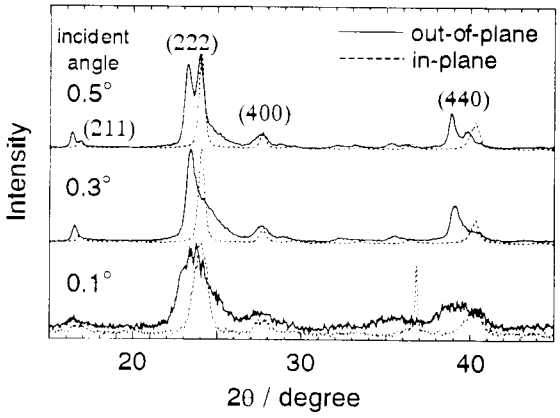

Fig.2 Change of out-of-plane and in-plane x-ray diffraction patterns of the ITO film with the incident angle.