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Excimer Laser Crystallization of Amorphous ITO Thin Film Deposited on PES

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1. Introduction

Recently, tin-doped indium oxide (ITO) has been extensively used as transparent conducting oxide materials in most flat panel displays, due to its properties of low electrical resistivity and high transmissivity to visible light in a thin film form [1-3]. The resistivity of ITO films should be kept as low as possible for better quality, larger scale and high-speed response of the image of flat panel displays. Though the precise mechanism has not been clearly explained in electrical conducting of polycrystalline ITO, in general, polycrystalline structure has a lower resistivity than amorphous structure. And then the fabrication method of poly-ITO is one of the current technical issues in ITO film. However, due to thermal limit of organic plastic film used as substrate, the crystallization of ITO film on plastic film inherently has a thermal obstacle.

In AMLCD matrix, excimer laser is a very useful method to crystallize the amorphous Si film on a non-heat-tolerant substrate without incorporating thermal damage on it [4]. Futhermore the absorption coefficient of ITO ($\sim 10^{-5}$ cm^{-1}) is similar to that of amorphous silicon ($\sim 10^{-6}$ cm^{-1}) at 308nm XeCl excimer laser [5].

In our research, the feasibility of new crystallization method of ITO thin films on PES was investigated by introducing XeCl excimer laser which has 20ns pulse duration.

2. Experimental Procedure

ITO thin film was deposited by DC magnetron sputtering on PES film. The PES film was cleaned by argon sputtering followed by plasma treatment. ITO was deposited at room temperature and its thickness was approximately 1400-1500A. The schematic diagram of DC magnetron sputtering system was illustrated in Fig. 1.

The crystallization behavior of amorphous ITO thin films by irradiation with XeCl (308nm) excimer laser (Lamda Physik, Compex 201, pulse duration : 20ns) and homogenizer optical system in air at room temperature was investigated by varying energy density, pulse number (single shot, multi shot and scan shot) and repetition frequency (1~10 Hz) of laser pulses [2].

The surface of ITO film was analyzed by SEM and XRD.

3. Results and Discussion

The surface of ITO film was investigated by XRD. It was confirmed that amorphous ITO film was crystallized by excimer laser irradiation. The XRD patterns were illustrated in Fig. 2. When the energy density of laser pulse was fixed at 60mJ/cm^2, the intensity of XRD peak was saturated. There was no significant variation of the crystallinity with changing the repetition frequency due to short pulse duration (20ns) of excimer laser beam. The similar result was reported for amorphous silicon crystallization [6].

Fig. 3 shows FESEM images of ITO films after laser crystallization at energy density of 60mJ/cm^2. The pulse number was fixed at 96% overlap-scan mode. Fig.3 (a) shows the contrast of microstucture between irradiated and non-irradiated region. The irradiated amorphous ITO was transformed into polycrysalline. It can be explained by photoexitation mechanism resulted from the conventional excimer laser crystallization. As shown in Fig. 3 (b), the grain of a transformed poly ITO can grow laterally before the impingement between grains. The size of grain is approximately 300nm after irradiation.

4. Conclusions

It was proposed that the novel crystallization of ITO thin films followed by XeCl excimer laser irradiation. The critical condition of energy density is 60 mJ/cm^2 through XRD and SEM analysis. It is concluded that the temporary heating processes using pulsed laser light can control the crystallization of a-ITO thin films without thermal damage of substrate.

Acknowledgments

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References

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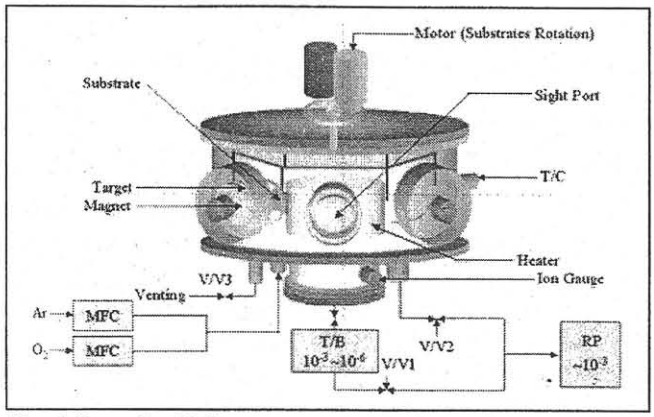


Fig. 1 Reactive DC manetron sputter

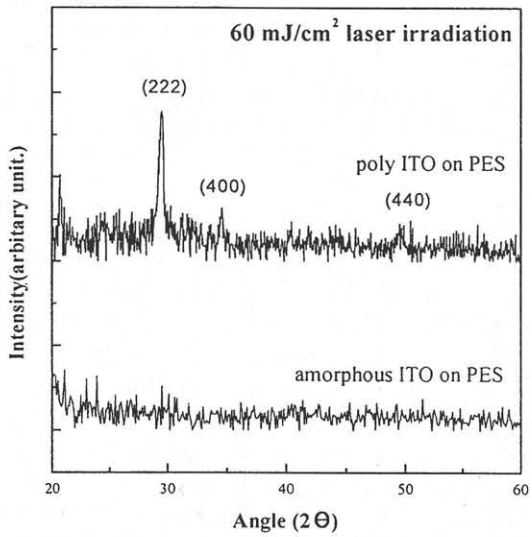
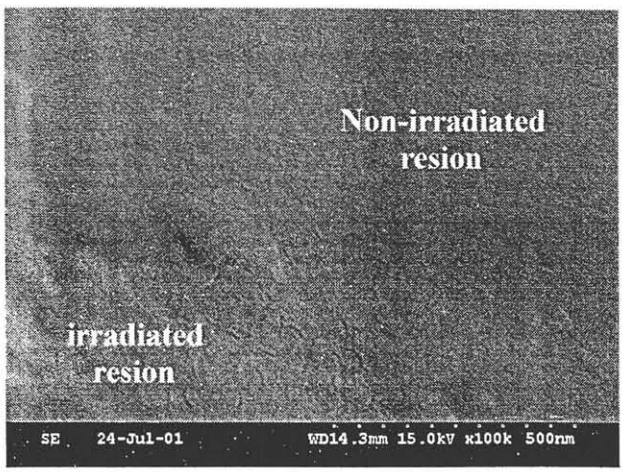
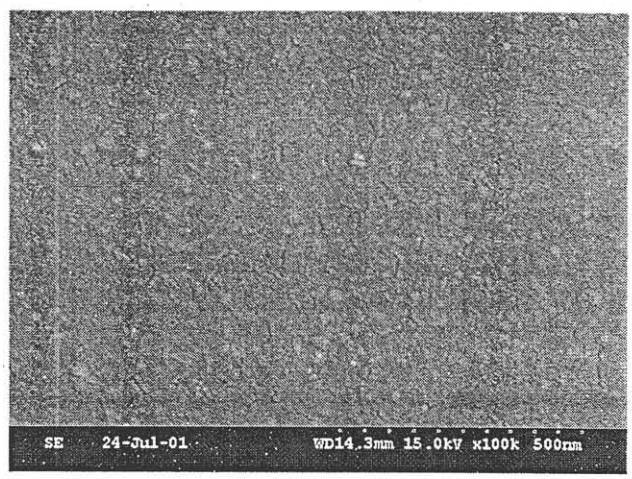


Fig. 2 XRD spectra of amorphous ITO and poly ITO on PES after laser irradiation



(a)



(b)

Fig. 3 Plane view FESEM image of poly-ITO films after laser irradiation (a) at the boundary between poly-ITO and a-ITO, (b) on surface of poly-ITO