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Plasma-assisted formation of oxide thin film at atmospheric pressure and unheated process

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Functional oxide thin films such as zinc oxide, titanium dioxide, or aluminum oxide are indispensable in next-generation electronics field. These oxide thin films are generally prepared thermal processes at several 100 degrees Celsius. The thermal processes, however, makes oxide thin film preparation on flexible film substrates difficult. In order to avoid thermal damage of substrates, reaction energy with low temperature and high reactivity is required. In this study, atmospheric pressure plasma has been used as reaction energy for formation of oxide thin films. Atmospheric pressure plasma has reactive oxygen species (ROS) such as hydroxyl radical, oxygen atom, and ozone. These ROSs enable to promote oxidation reaction of precursor at low temperature. In this paper, a zinc oxide thin film has been formed on a PET film substrate with atmospheric pressure plasma irradiation.

A 0.1 mol/L zinc acetate solution with some amount of additional 28 % ammonium hydroxide was used as a precursor for zinc oxide formation [1-2]. The aqueous precursor solution was coated on a PET film and dried in air.

Figure 1 shows experimental setup of atmospheric pressure plasma generation and irradiation on a film specimen [3]. The atmospheric pressure plasma was generated by dielectric barrier discharge in a reaction chamber. Helium gas with a flow rate of 2 L/min was feed into the chamber as a plasma source gas. A pair SUS discs with a diameter of 54 mm and a thickness of 10 mm covered by a glass was used as electrodes. The gap length between two glasses was 1 mm. Rectangular AC high voltage with amplitude of 5 kV and a frequency of 5 kHz was applied between the electrodes. The film specimen was located on the surface of the HV electrode glass. The film specimen was irradiated by the atmospheric pressure plasma for 5 minutes. After plasma irradiation, the film specimen was analyzed by X-ray diffraction.

Figure 2 shows XRD profiles of film specimens with/without atmospheric pressure plasma irradiation. As shown in Fig. 2, intensity of a diffraction peak ZnO(002) at 2q=34 deg. became high after the atmospheric pressure plasma irradiation. It can be expected that the peak of zinc oxide clearly appears due to the increase in the oxygen concentration in the atmospheric pressure plasma.

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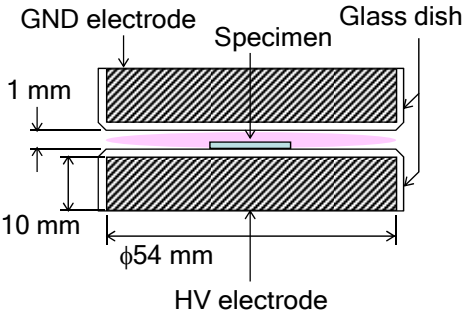

Figure 1 Experimental setup of atmospheric pressure plasma irradiation on precursor specimen.

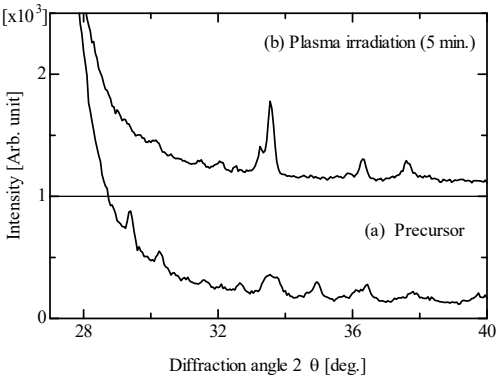

Figure 2 XRD profiles of specimen with/without atmospheric pressure plasma irradiation.

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