High Conductivity ZnO:Al Films Deposited by Atomic Layer Deposition

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ZnO films are widely used as a window layer for thin film photovoltaic (PV) devices such as solar cells and light emitting diodes, due to their low materials costs and low growth temperature [1-2]. The n-type conductivity of ZnO can be controlled by doping with trivalent atoms such as aluminum, gallium or indium [3]. In particular, aluminum-doped ZnO (AZO) is well suited for use in PV applications owing to its high electrical conductivity and excellent optical transparency in the near-infrared and visible regions [4].

In this study, we investigated the electrical, structural, and optical properties of Al-doped ZnO (AZO) thin films approximately 50 nm thick grown by atomic layer deposition (ALD) on glass substrates at 200 ℃. An H_2O pretreatment was conducted for all AZO samples. The electrical properties of the AZO thin film were improved after the pretreatment process. The Al doping concentrations were controlled by inserting an Al_2O_3 cycle after every "n" ZnO cycles while varying n from 99 to 16. As the doping concentration increases, the resistivity decreases and the optical band gap increases. When the Al_2O_3 cycle ratio is 5%, the electrical resistivity showed the lowest value of 4.66 x 10^{-3} Ω cm. A carrier concentration of 1.10 x 10^{20} cm^{-3}, and the optical transmittance exceeding 90 % were obtained in the visible and near-infrared region. The thin film was strongly textured along the (100) direction in the X-ray diffraction patterns.

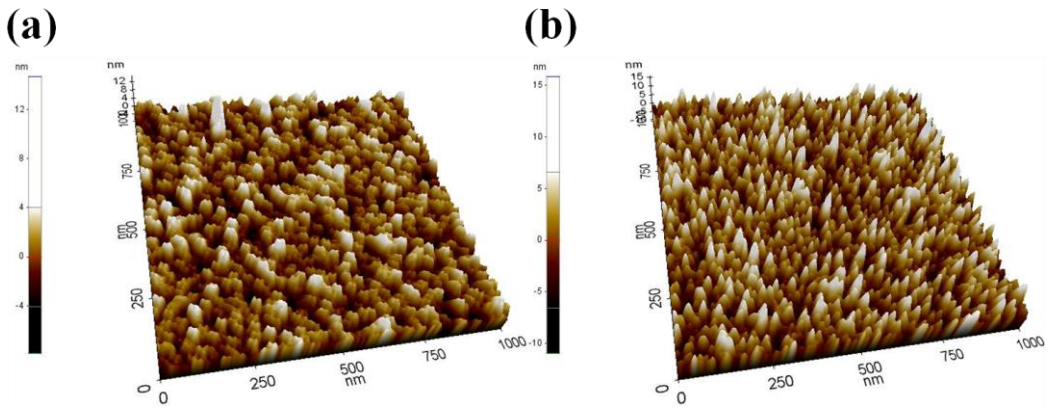

Fig. 1. AFM images of ZnO thin films (a) with and (b) without a H_2O pretreatment of the substrate.

Acknowledgment

This work was supported by the DGIST R&D Programs of the Ministry of Science, ICT & Future Planning of Korea (15-BD-05).

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