Chemical preparation of ZnO film with controlled morphology.

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Introduction

Zinc oxide (ZnO) is a n-type semiconductor and the films are employed to several applications due to its electrical, optical, and acoustic characteristics. We reported a chemical deposition of the ZnO film on nonconductive substrates from an aqueous solution containing zinc nitrate and dimethylamineborane (DMAB)[1,2] .The morphology of ZnO grains can be controlled by adjusting preparation conditions such as solution formulation and preparation temperature. This paper reports the effects of preparation condition on the morphology.

Experimental

150-nm-thick ZnO films were prepared by immersing glass substrates in a aqueous solution containing a zinc nitrate hydrate, DMAB and additives at solution temperature 333 to 353 K. Prior to deposition, the substrates were rinsed in NaOH solution and then catalyzed using an industrially employed three-step Sn/Ag/Pd activation process (Okuno Chemical Industreies, Techno Clear SN, AG and PD). Surface morphology and cross section were observed scanning electron micrographs (SEM). XRD measurement was carried out with a conventional θ / 2 θ scanning method. Optical transmission spectrum was recorded by scanning wavelength in the range of 200-700 nm with reference to air.

Result

The ZnO film was obtained irrespective of preparation conditions. The ZnO film prepared at 338 K showed random orientation. The preferred orientation changed depending on the temperature and a (0001) oriented ZnO film was obtained at 353 K.

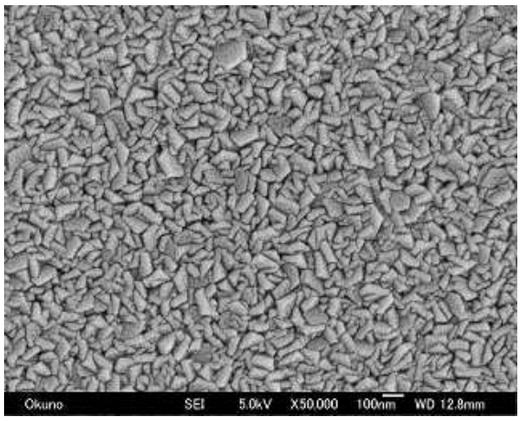
Fig.1 shows the surface morphologies of ZnO films prepared at 338 and 353 K. The ZnO films were composed of aggregates of hexagonal columnar grains of ca 100 nm in size and we could not locate any pore. The grain size decreased with the decrease in zinc nitrate concentration and open-structure ZnO film layer was obtained at 338 K. The ZnO film showed high optical transmission of approximately 80% at 600 nm.

Conclusion

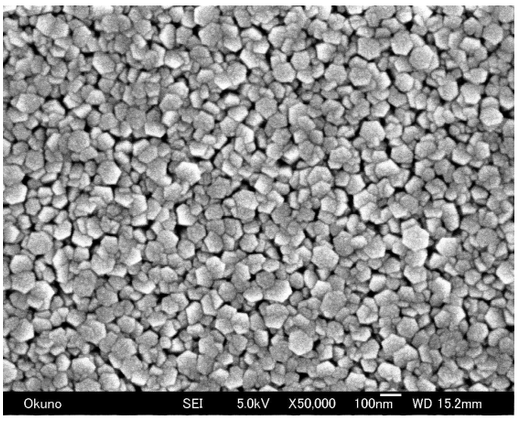
The grain morphology and preferred orientation of chemically prepared ZnO films could be controlled by optimuming the operating conditions. The (0001) oriented ZnO film was obtained at temperature 353 K and dense and open-structure ZnO layer could be obtained.

Reference

1) M.Izaki and T. Omi, J. Electrochem. Soc., 144, L3 (1997)
2) M.Izaki and J. Katayama. J. Electrochem. Soc., 147, 210 (2000)



(a) 338 K



(b) 353 K

Fig.1 SEM images of ZnO films chemically prepared at 338 K and 353 K.