Growth of Tin Oxide Film with Buffer Layer on Sapphire Substrate by Mist Chemical Vapor Deposition

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1. Background and Purpose

The wide band-gap oxide semiconductors have attracted substantial attentions due to their physical properties and potential technological applications. Tin oxide (SnO_2) is an abundant material and usually used for transparent conducting electrodes and gas sensors. Furthermore, tin oxide can be applied to power devices because of the wide bandgap property (~4eV). In this study, we deposited SnO_2 film on buffer layers on sapphire substrates by mist chemical vapor deposition (mist-CVD)[1].

2. Experimental Method

The SnO_2 was deposited on m-plane sapphire substrates at various temperatures by fine channel-type mist-CVD as shown in Fig.1. Before thin film deposition, we deposited buffer layer using tin acetate ($Sn(CH_3COO)_2$) solution with the concentration of 0.04 mol/L. The deposition temperature of buffer layer is varied from 500°C to 850°C. Tin chloride ($SnCl_2$) was used for SnO_2 thin film with the concentration of 0.1 mol/L. In order to carry the precursor to the reactor, we used nitrogen gas with the flow rate of 4 L/min.

3. Results and Discussion

According to SEM and AFM images (Fig. 2), surface of the sample with the buffer seemed to be smoother than that of the sample without the buffer. The XRD pattern revealed the single crystalline nature of the film having rutile structure by measuring XRD of θ-2θ scan and ϕ scan. From the XRD ω-rocking curves results, we found that full width at half maximum (FWHM) showed the lowest value of 0.12 deg for the sample with the buffer layer grown at 650 °C as shown in Fig. 3. From these results, the use of the buffer layer effectively improved the crystal quality and surface roughness of SnO_2 thin film layer.

Reference

[1] Zenji Yatabe, et. al., Phys. Status Solidi C, 14, 1600148 (2017).

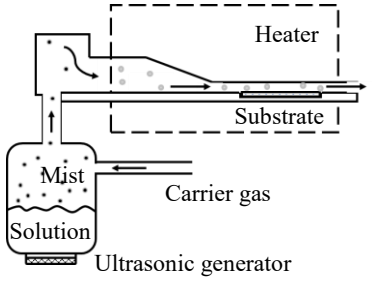

Fig: 1. Fine channel-type mist-CVD system

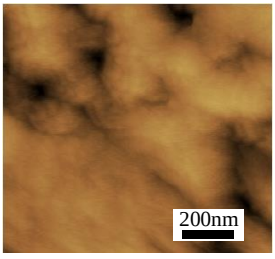

Fig: 2. AFM image of SnO_2 film with buffer layer

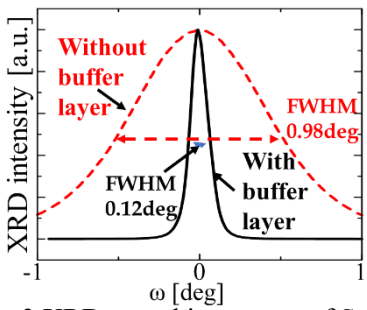

Fig: 3 XRD ω-rocking curves of SnO_2 films with and without buffer layer