

In₂O₃ Thin Films Deposited Using InCl₃ by Mist CVD Method

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In₂O₃ is an oxide semiconductor with high transparency and conductivity, widely used in transparent conducting films and channel layers of thin-film transistors (TFTs). For application to high-mobility TFTs, we have been studying the deposition of ~10 nm In₂O₃ films on SiO₂/Si substrates by the mist chemical vapor deposition (Mist CVD) method. Mist CVD is a technique in which the precursor solution is atomized by ultrasonic vibration and thermally decomposed on a heated substrate. The precursor solution is typically prepared by dissolving metal powders in an acidic solvent such as HCl. In our previous studies, it was confirmed that decreasing the HCl concentration in the solution during Mist CVD resulted in thinner In₂O₃ films [1]. On the other hand, when the concentration approaches the solubility limit, undissolved In₂O₃ powder remains, which negatively affects the film quality. To address this issue, we focused on InCl₃ as an alternative precursor. Since InCl₃ is easily soluble in deionized water, HCl is not required to prepare the solution, and it is expected that thinner In₂O₃ films can be obtained simply by reducing the InCl₃ concentration [2]. In this study, In₂O₃ thin films were deposited on SiO₂/Si substrates by Mist CVD using InCl₃ solutions with concentrations between 0.0050 and 0.20 mol/L. The solutions were used after visually confirming complete dissolution by visual inspection.

Figure 1 shows the film thickness as a function of InCl₃ concentration measured using SE and TEM. The results show that the In₂O₃ films became thinner as the InCl₃ concentration decreased. An In₂O₃ film thickness of about 10 nm was achieved at the concentration of 0.0050 mol/L. Figure 2 shows the bird's-eye FE-SEM images of In₂O₃ films grown at the InCl₃ concentrations of 0.0050 and 0.20 mol/L. At the concentration of 0.0050 mol/L, the smoother surface was obtained with smaller crystal grain sizes, while at 0.20 mol/L, the three-dimensional surface was obtained with large crystal grain sizes. The flattening of the surface with decreasing InCl₃ concentration can be explained by the smaller grain size. In the presentation, we will comprehensively discuss the structure of the grown In₂O₃ thin films, including their electrical properties.

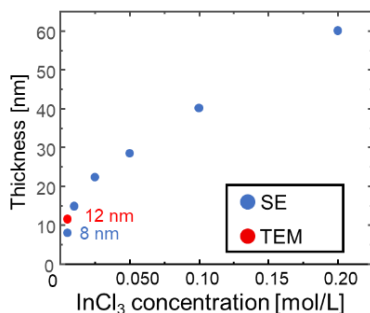


Figure 1. In₂O₃ film thickness using SE and TEM.

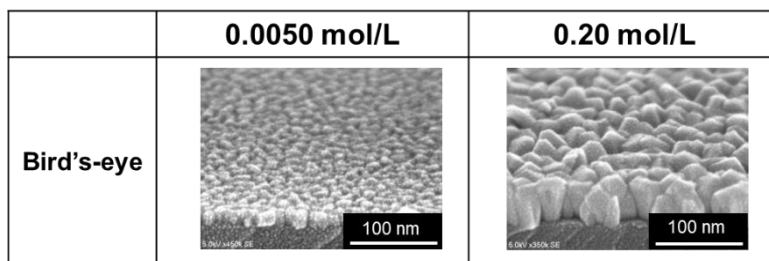


Figure 2. Bird's-eye FE-SEM images of In₂O₃ films grown at InCl₃ concentrations of 0.20 and 0.0050 mol/L.

[1] A. Taguchi *et al.*, Phys. Status Solidi B, **259** 2100414 (2022).

[2] E. M. Kartzmark, Can. J. Chem. **52** 3459 (1974).