Atomic Layer Deposition of Indium Gallium Zinc Oxide (IGZO) Semiconductor Thin Films: From Precursor to Thin Film Transistor Application

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Oxide semiconductor thin film transistors (TFTs) have been extensively researched as a switching device in display industry. Also, the amorphous indium gallium zinc oxide (a-IGZO) have been already adopted for the mass-production of OLED TVs because it showed remarkable performances such as high mobility (>10cm^2/V. sec), low process temperature (<350ºC), optical transparency (>3eV) and low-cost fabrication process. Recently, there are a few efforts to fabricate atomic layer deposited (ALD) IGZO thin films and demonstrating their device properties. However, ALD IGZO systems are quite difficult to understand their electrical and chemical properties because each precursor is affected to growth mechanism, crystallinity, and electrical performance.

In this talk, I will show key properties (growth behavior, electrical/chemical properties, and device performances) of indium gallium oxide (IGO) and indium gallium zinc oxide (IGZO) thin films depending on a few In and Ga precursor species. There films are deposited using the concept of "super-cycle" – IGO (n cycle InO_x – m cycle GaO_x) and IGZO (n cycle of InO_x – m cycle of GaO_x – k cycle of ZnO). Then, the bottom gate-top contact (inverted staggered structure) thin film transistors were fabricated by ALD processes. The devices with IGO and IGZO active layers are named Device A (IGO TFT using Indium A precursor), Device B (IGZO TFT using indium B precursor), Device C (IGZO TFT using Indium B precursor), Device D (IGZO TFT using indium B' precursor).

The representative transfer curves and performance parameters are shown in Figure 1 and Table 1. The IGZO device D exhibited boost mobility of 74.4 cm^2/V.sec. but the IGZO device B and C with different Indium precursors showed different mobilities of devices. It may result from a different growth rate and film composition. Thus, it is believed that ALD IGZO TFT will be very promising for the next generation switching transistor beyond the low-temperature poly-silicon (LTPS) thin film.

Figure 1. (a) Device structure, (b) transfer characteristics (I_D vs V_{GS}) of the device A, B,C and D.