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Sol-gel deposited TiInO thin-films transistor with Ti effect

Jung-Hye Kim[1], Dae-Ho Son[2], Dae-Hwan Kim[2], Jin-Kyu Kang[2], Ki-Ryong Ha[1]

[1]Deparment of Chemical Engineering, Keimyung University, Daegu, Korea

[2]Public & Original Technology Research Center, DGIST, Daegu, Korea

In recent times, metal oxide semiconductors thin films transistor (TFT) , such as zinc and indium based oxide TFTs, have attracted considerable attention because of their several advantageous electrical and optical properties. There are many deposition methods for fabrication of ZnO-based materials such as chemical vapor deposition, RF/DC sputtering and pulsed laser deposition. However, these vacuum process require expensive equipment and result in high manufacturing costs. Also, the methods is difficult to fabricate various multicomponent oxide semiconductor. Recently, several groups report solution processed metal oxide TFTs for low cost and non vacuum process. In this study, we have newly developed solution-processed TFTs based on Ti-related multi-component transparent oxide, i. e., InTiO as the active layer.

We propose new multicomponent oxide, Titanium indium oxide(TiInO), to fabricate the high performance TFT through the sol-gel method. We investigated the influence of relative compositions of Ti on the electrical properties.

Indium nitrate hydrate [$In(NO_3).xH_2O$] and Titanium isobutoxide [$C_{16}H_{36}O_4Ti$] were dissolved in acetylacetone. Then monoethanolamine (MEA) and acetic acid (CH_3COOH) were added to the solution. The molar concentration of indium was kept as 0.1 mol concentration and the amount of Ti was varied according to weighting percent (0, 5, 10%). The complex solutions become clear and homogeneous after stirring for 24 hours. Heavily boron (p+) doped Si wafer with 100nm thermally grown SiO_2 serve as the gate and gate dielectric of the TFT, respectively. TiInO thin films were deposited using the sol-gel solution by the spin-coating method. After coating, the films annealed in a tube furnace at 500℃ for 1hour under oxygen ambient.

The 5% Ti-doped InO TFT had a field-effect mobility 1.15$cm^2/V \cdot S$, a threshold voltage of 4.73 V, an on/off current ratio grater than 10^7, and a subthreshold slop of 0.49 V/dec. The 10% Ti-doped InO TFT had a field-effect mobility 1.03 $cm^2/V \cdot S$, a threshold voltage of 1.87 V, an on/off current ration grater than 10^7, and a subthreshold slop of 0.67 V/dec.