YIZO TFT using sol-gel process

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Created by: Hyun Jae Kim

Electrical Properties of Yttrium–Indium–Zinc-Oxide Thin Film Transistors Fabricated Using the Sol–Gel Process and Various Yttrium Compositions

This study was the first to investigate the fabrication of yttrium–indium–zinc-oxide (YIZO) thin film transistors (TFTs) using the sol–gel process. YIZO thin films were made using various yttrium (Y) compositions from 10 to 20%. Thermogravimetry and differential scanning calorimetry (TG– DSC) data from the 15% Y sample revealed that the YIZO thin films crystallized above the temperature of 535°C, much hotter than that of indium– gallium–zinc-oxide (IGZO) thin films. The best performance of YIZO TFTs was observed with a 15% ratio of Y to Zn: this yielded a saturation mobility of 1.12 $cm^2 V^{-1} s^{-1}$, an on/off ratio of 4.61 x 10^5, a threshold voltage of 0.54 V, and a subthreshold swing of 1.03 V/decade. This study also assessed the post-annealing temperature dependence of YIZO TFTs. The findings demonstrated the possibility of using Y to replace gallium (Ga), which has been used in previously reported solution-processed IGZO TFTs.

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Table I. Comparison of various parameters including μ_{FE}, V_{th}, *S*-factor, and on/off ratios for YIZO TFTs with three different Y ratios and IGZO TFTs.

TFTs	μ_{Sat} ($cm^2 V^{-1} s^{-1}$)	V_{th} (V)	*S*-factor (V/dec)	On/off ratio
IGZO	0.46	0.11	0.63	1.32×10^6
YIZO (10% Y)	1.92	−11.4	1.53	5.37×10^4
YIZO (15% Y)	1.12	0.54	1.03	4.61×10^5
YIZO (20% Y)	0.08	10.6	1.70	5.34×10^4

Table II. Comparison of various parameters including μ_{FE}, V_{th}, *S*-factor, and on/off ratios for the three samples fabricated using differing post-annealing temperatures.

Post-annealing temperature (°C)	μ_{Sat} ($cm^2 V^{-1} s^{-1}$)	V_{th} (V)	*S*-factor (V/dec)	On/off ratio
350	1.87×10^{-3}	−4.34	3.65	9.68×10^2
450	0.23	−19.36	1.70	1.87×10^5
550	1.12	0.54	1.03	4.61×10^5

In table 1, of all the tested YIZO samples, the 15% Y sample exhibited the best transfer characteristics, which were competitive with IGZO TFT results previously reported by our group. For the 350 °C post-annealing sample, transfer characteristics resembled those of an insulator because chemical reactions were done imperfectly due to the low annealing temperature and, as a results, there seemed to exist organic remainders, which can affect TFT performance. The 450 °C post-annealing sample had just begun to crystallize, at which temperature the formation of dehydroxylation and alloy mechanism was unfinished. Thus, the sample exhibited reasonable on-off characteristics but the threshold voltage of TFT was negatively shifted compared to the 550 °C post-annealing sample.

Keywords

Yttrium-indium-zinc-oxide (YIZO);Thin film transistors;Solution process;Post-annealing temperature dependency