Thermal activation effects on the stoichiometry of IGZO TFTs

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Thermal activation effects on the stoichiometry of indium zinc oxide thin-film transistors

The thermal activation effects on the stoichiometry of indium zinc oxide (IZO) thin-film transistors (TFTs) deposited by radio frequency magnetron sputtering process under different oxygen pressure, were investigated as a function of annealing temperature and environment conditions. The IZO TFTs, with channel layers deposited at pure Ar, were annealed at different temperature in oxygen ambient. Otherwise, in case of IZO TFTs deposited at Ar/O_2 flow ratio of 40/2, were annealed in different ambient at 300 °C. With IZO layers deposited at pure Ar, deposited at pure Ar, the IZO TFT has Ohmic properties initially. Although, the IZO TFT showed the transfer characteristic after annealed at 300 °C, it was degraded at 500 °C. In case of IZO TFT deposited at Ar/O_2 flow ratio of 40/2, the characteristics were changed from insulating to transfer (in air) or an Ohmic properties (in vacuum) after annealing at 300 °C. X-ray photoelectron spectroscopy (XPS) measurements showed that these thermal activation effects were caused by the stoichiometry changing correlated to the atomic arrangements such as oxygen absorption, the connections of In, Zn, and O clusters, and the deoxidation at In-O.

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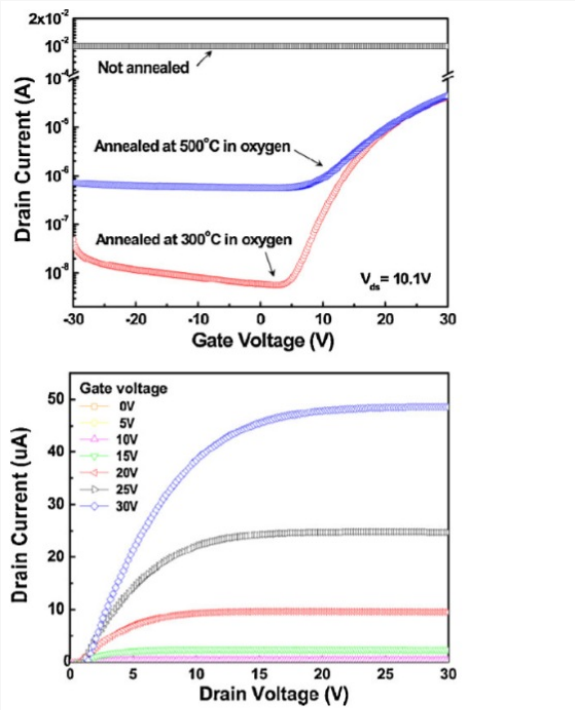

Figure 2 (online colour at: www.pss-a.com) Transfer curve of IZO TFT deposited in pure Ar according to annealing temperature (top image) and output curve of the IZO TFT deposited in pure Ar and annealing at 300 °C (bottom image).

Figure 2 shows the transfer characteristics of IZO TFTs deposited in pure Ar, annealed at various temperature in oxygen ambient. Initially, the IZO TFT without post-annealing has Ohmic properties, 10^{-2} A of current flows independent to gate bias. IZO TFT showed the transfer characteristic after annealing at 300 °C, and its channel mobility, threshold voltage, s-factor, and on-off ratio are 1.97 cm^2/Vs, 14.6 V, 3.4 V/dec, and ~10^4, respectively. However, after annealing at 500 °C, the off current of ZnO TFT was raised up to 10^{-6} A, and then on-off ratio was degraded from 10^4 to 10^2.

Keywords

Annealing;Electrical properties;Indium-zinc oxide;Sputtering;Stoichiometry;Thin-film transistor