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Fabrication of Thin Film Transistors based on Sol-Gel Derived Oxide Semiconductor Layers by Ink-Jet Printing Technology

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We have fabricated solution processed oxide semiconductor active layer for thin film transistors (TFTs). The oxide semiconductor layers were prepared by ink-jet printing the sol-gel precursor solution based on doped-ZnO. Inorganic ZnO-based thin films have drawn significant attention as an active channel layer for TFTs applications alternative to conventional Si-based materials and organic semiconducting materials, due to their wide energy band gap, optical transparency, high mobility, and better stability. However, in spite of such excellent device performances, the fabrication methods of ZnO related oxide active layer involve high cost vacuum processes such as sputtering and pulsed laser deposition. Herein we introduced the ink-jet printing technology to prepare the active layers of oxide semiconductor. Stable sol-gel precursor solutions were obtained by controlling the composition of precursor as well as solvents and stabilizers, and their influences on electrical performance of the transistors were demonstrated by measuring electrical parameters such as off-current, on-current, mobility, and threshold voltage. Microstructure and thermal behavior of the doped ZnO films were investigated by SEM, XRD, and TG/DTA. Furthermore, we studied the influence of the ink-jet printing conditions such as substrate temperature and surface treatment on the microstructure of the ink-jet printed active layers and electrical performance. The mobility value of the device with optimized condition was about 0.1-1.0 cm^2/Vs and the on/off current ratio was about 10^6. Our investigations demonstrate the feasibility of the ink-jet printed oxide TFTs toward successful application to cost-effective and mass-producible displays.

Keywords: Ink-jet printing, Oxide semiconductor, Thin-film transistors, Direct printing

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Oxidation-free Cu material for printed electronics

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Developing a low cost printing material that can replace silver for the formation of a conducting pattern is an important issue in printed electronics. We report a novel approach using a non-oxidized copper material during the printing and sintering process under ambient conditions, which was previously considered unachievable. An attempt was made to understand the conversion process of cuprous oxide nanoparticle aggregates on metallic copper crystals through chemical reduction in the solution phase. The detailed mechanism for this conversion, including the role of the surfactant and crystal growth, was examined.

Keywords: printing, Cu