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Solution - Processed Oxide Thin - Film Transistors Using La - Ta - O/Bi - Nb - O Stacked Gate Insulator.

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More than a decade, a solution-based fabrication process has attracted much attention as an alternative to the conventional vacuum deposition process for fabrication of various electronic devices, because this process could facilitate dramatic low cost and low energy processing due to its low equipment costs, process simplicity and direct patternability by using various printing techniques. In recent years, oxide-based thin-film transistors (TFTs) with solution-processed conductive oxide channels such as ZnO, In-Zn-O and In-Ga-Zn-O have been reported. However, most of those TFTs employed solution process only for a channel layer while the rest parts of transistors were fabricated by conventional vacuum deposition processes. In order to achieve ultra low cost and low-energy fabrication, it is very important to realize a total solution-based process, which means solution derived materials are applied not only to a channel layer but also to other layers in the transistor including a gate insulator layer and electrodes. Meanwhile it is needless to say that the totally solution processed transistors ought to have a high device performance for putting them into practical use. With those motivations, we already developed a ferroelectric-gate thin-film transistor in which all parts of the device were fabricated from solution-derived materials only and confirmed their good device performance [1]

In this study, we focused on solution-processed oxide TFTs using stacked paraelectric gate insulator to achieve good electrical performance. We fabricated oxide TFTs on a glass substrate in which a gate electrode, a gate insulator and a channel were fabricated by chemical solution deposition (CSD) process. We adopted a LaNiO3 (LNO) film as a gate electrode, La-Ta-O (LTO)/Bi-Nb-O (BNO) stacked film as a gate insulator, In-Zn-O film as a channel and ITO film as source-drain electrodes. In particular, the LTO thin film was an amorphous insulator with a relative permittivity of ~22 and the leakage current of ~10-6A/cm2 at 1MV/cm applied field while the BNO thin film was a polycrystalline insulator with the relative permittivity of ~170 and the leakage current of ~10-4A/cm2 at 1MV/cm applied field. By stacking LTO and BNO films, a good gate insulator was developed, in which the relative permittivity, the leakage current and the surface flatness were simultaneously satisfied. The fabricated TFTs exhibited typical n-channel transfer characteristics with no hysteresis and good saturation in out-put characteristics. The obtained on/off current ratio, subthreshold voltage swing and field-effect mobility were about 108, and 220mV/decade and 8.5cm2/Vs, respectively. [1] T. Miyasako, B. N. Q Trinh, M. Onoue, T. Kaneda, P. T. Tue E. Tokumitsu, T. Shimoda Appl. Phys. Lett., 97, 173509 (2010).

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