Flexible Solution-processed Metal Oxide Thin Film Transistors Operated at 23 MHz Achieved by a Damage-free Patterning Process

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Metal oxide transistors (MOSs) have emerged as a promising platform for thin film transistor (TFT) because of their high uniformity, high electron mobility and satisfactory stability, even in the amorphous phase. Vacuum-based MOS deposition technology has been established for years, but its high initial cost and restricted deposition area limit the large area fabrication. As an alternative solution, solution-processed MOSs have been developed, and attracting more and more attention in recent years, whereas they are still less-used due to lower performance and lack of integration technology compared with vacuum-based type.

Here, state-of-the-art solution-processed indium-zinc-oxide (IZO) TFTs with high electron mobility, almost zero threshold voltage, excellent atmospheric stability and compatibility with wet patterning process has been developed. To meet the high-speed operation requirement of advanced applications, we developed a damage-free patterning process, using a photoresist that can be processed with aqueous Na_2CO_3 as a mild developer instead of conventional developers such as tetramethylammonium hydroxide. Based on the concept of printed/flexible high speed electronics, solution-processed IZO were fabricated on flexible polyimide (PI) substrate. The reliability of the patterning process and the TFT properties were discussed. The as-fabricated TFTs with a channel length (L) of 20.0 μm showed high field-effect motility up to 7 cm^2 V^{-1} s^{-1}, even with L of 1.7 μm, saturation mobility more than 1 cm^2 V^{-1} s^{-1} and high on-off current ratio up to 10^{10} (Fig.1). In addition, potential application to high-speed electronic circuits was demonstrated by cutoff frequency measurements, and a cutoff frequency of 23 MHz was achieved at 10 V. Furthermore, the IZO-based TFTs functioned well under moderate bending stress. Therefore, this technology is expected to open up opportunities for practical flexible devices with high-speed operation.

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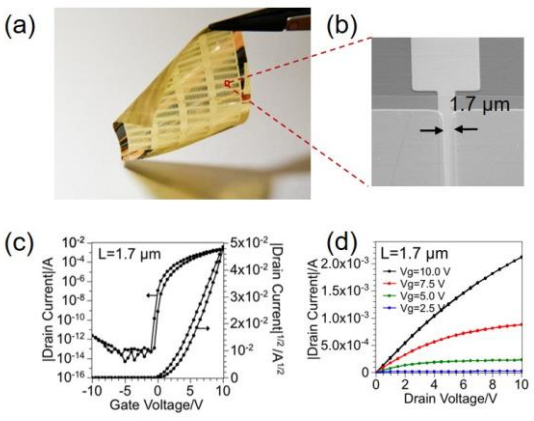

Fig.1. IZO-based TFTs fabricated through a damage-free patterning process on a PI substrate. (a) Photograph of as-fabricated TFT array. (b) SEM image of a TFT with L = 1.7 μm. Transfer characteristics at V_D = 10 V (c) and output curves (d) for TFT with L/channel width (W) =1.7 μm/1000 μm.