CMOS INVERTERS AND CIRCUITS BASED ON OXIDE THIN-FILM TRANSISTORS

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Thin-film transistors (TFTs) based on oxide semiconductors have the advantage of promising carrier mobilities and good switching characteristics, and they can be fabricated by low-temperature and scalable processes. Complementary metal-oxide-semiconductor (CMOS) technology employing oxide TFTs shows great potential in enabling flexible electronics with versatile functionalities and low-static power consumptions. Here flexible CMOS inverters comprising p-type SnO TFTs and n-type ZnO or IGZO TFTs integrated in three different configurations were implemented and compared, as shown in Fig. 1. First, the planar inverter comprising bottom-gated SnO and ZnO TFTs with a geometric aspect ratio, (W/L)p / (W/L)n, of 5 had a static voltage gain of ~ 10 V/V at a supplied voltage (VDD) of 10 V [1]. However, the gain decreased as the inverter was subjected to a mechanical tensile strain, which may be ascribed to the degradation of TFT mobilities. Second, the vertically-stacked inverter composed of a top-gated SnO TFT and a bottom-gated ZnO TFT with (W/L)p / (W/L)n of 1 showed a gain of ~ 34 V/V at VDD of 10 V [2]. The change of voltage transfer characteristics was negligible when the inverter was bent to various curvatures. Last, the staggered inverter consisting of a bottom-gated SnO TFT and a top-gated IGZO TFT with (W/L)p / (W/L)n of 1 exhibited a high gain of 370 V/V and balanced noise margins at VDD of 10 V [3]. The inverter performance was stable against mechanical bending down to a radius of □5 mm. Flexible circuits, such as oscillators, amplifiers and SRAM cells, based on the CMOS oxide inverters were also demonstrated. For instance, a five-stage flexible ring oscillator based on the coplaner inverters showed an oscillation frequency of ~18 kHz at VDD of 12 V [1]. A flexible amplifier containing a coplanar inverter, a feedback resistor and a coupling capacitor was used to enhance the signal-to-noise ratio of a monolithically integrated ZnO piezoelectric tactile senor from 26 dB to 66 dB. A SRAM cell consisting of two staggered CMOS inverters and two n-type access transistors exhibits a static noise margin of 0.73 V, a read static noise margin of 0.074 V and a write noise margin of 1.4 V.

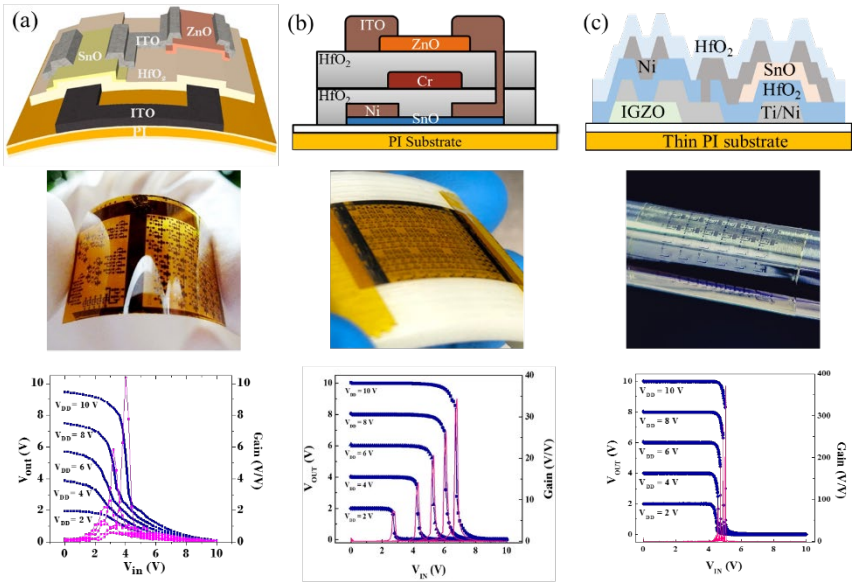

Figure 5 – Schematics, photographs and voltage transfer characteristics of flexible (a) coplanar inverter comprising bottom-gated SnO and ZnO TFTs, (b) vertically-stacked inverter comprising top-gated SnO and bottom-gated ZnO TFTs, and (c) staggered inverter comprising bottom-gated SnO and top-gated ZnO TFTs.

References:

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