High Driving Ability of Bulk-Accumulation Oxide TFTs for 8k4k Displays

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For large-size displays, achieving resolutions as high as 8k4k is not much of a challenge, as the thin-film transistors (TFTs) that drive the display can be designed to be large enough to meet the high current demands. The case is different when such high resolutions are required for small-size displays; the reason being that the size of the TFTs is limited to only small dimensions, making it very difficult to meet the required drive current levels. In other words, a high pixel density (ppi) is required. Here, an amorphous-oxide semiconductor (AOS)-based bulk-accumulation TFT that achieves high drive currents for small channel dimensions, is proposed for small-size 8k4k displays. A bulk-accumulation TFT is a dual-gate TFT with the two gates shorted together. In other words, the top-gate and bottom-gate are electrically synced and thus driven by one gate signal. Bulk-accumulation, which is a condition in which the channel accumulation layer is not confined only to the gate-insulator/active-layer interfaces, but extends the entire depth of the active-layer, is achieved when the active-layer thickness is around 20 nm or less [1].

This presentation will review the work we have done so far with bulk-accumulation amorphous-indium-gallium-zinc-oxide (a-IGZO) TFTs, including their design, fabrication and superior performance in comparison to single-gate-driven TFTs of similar dimensions. It will be shown that the fabrication of bulk-accumulation TFTs is fully compatible with standard display fabrication processes, where the metal used to make the pixel electrode is used to make the top-gate. Of particular interest is an offset gate design that results in zero TFT parasitic capacitance (i.e. no overlap between gates and source/drain electrodes) for fast dynamic operation, without limiting the advantages of bulk-accumulation. Compared to single-gate driven TFTs, some of the advantages of bulk-accumulation TFTs include higher on-current, turn-on voltage close to zero volts, smaller subthreshold swing values, better device-to-device uniformity, and better negative bias and light-illumination stress [2-10]. In the presentation, the speed of the bulk-accumulation TFTs will be verified by fast switching ring oscillators. The presentation will show bulk-accumulation TFT-based gate drivers that are less than 30 micrometer in width (pitch) and have <2 μm pulse widths, including a prototype high resolution AMOLED display that is diven with bulk-accumulation TFTs and has an integrated bulk-accumulation TFT-based gate-driver.

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