Design, Analysis, and Test of Low-Power and Reliable Flexible Electronics

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Flexible electronics are emerging as an alternative to conventional Si electronics for large-area low-cost applications such as e-paper, smart sensors, and disposable RFID tags. By utilizing inexpensive manufacturing methods such as ink-jet printing and roll-to-roll imprinting, flexible electronics can be made on low-cost plastics just like printing newspapers. However, the key elements of flexible electronics, thin-film transistors (TFTs), have a much slower operating speed and are less reliable than their Si electronics counterparts. Furthermore, depending on the material properties, TFTs are usually mono-type (either p- or n-type) devices - making air-stable complementary TFT circuits is very challenging and not feasible for most TFT technologies. Existing design and test technologies for Si electronics, therefore, cannot be applied to flexible electronics. Other limiting factors such as high supply voltage, large process variation, and lack of trustworthy device modeling also make designing larger-scale, robust TFT circuits a significant challenge.

This talk discusses some recent progress in robust circuit/system design and test of flexible electronics. We will first give an overview of reliability simulation for predicting TFT degradation under bias-stress. A reliability analysis framework, which has successfully analyzed the reliability of an amorphous-silicon (a-Si) TFT scan driver for TFT-LCD displays, will be discussed [1]. We then discuss solutions that can make TFT circuits operable under a lower supply voltage and can equip them with post-fabrication tunability for reliability and performance enhancement. Specifically, we will present a new design style, named Pseudo-CMOS [2], which has been successfully validated in a p-type organic TFT technology [3] as well as in a n-type InGaZnO (IGZO) TFT technology.

We further discuss the test challenges and the need for system solutions to overcome the inherent limitations on device/circuit yield and reliability.

References

