Chapter 8

Future Prospects

Low temperature polycrystalline silicon thin film transistors (LTPS-TFTs) with better performance will be essential to the next generation of displays, since not only pixel array but also other functional circuits will be integrated on the same glass substrate. About low temperature polycrystalline silicon thin film transistor devices and circuits related with this dissertation, there are still many interesting research opportunities and topics described as follows:

(1) For further improvement of uniformity, additional hydrogen passivation steps are required. Since the hydrogen radicals penetrate into the gate oxide and passivate the active poly-Si layer effectively through the side-wall poly-Si channels. Besides, channel stripe number and stripe distance must be optimized to obtain excellent device uniformity according to each factory.

(2) In addition to gate oxide quality, grain crystallinity is another dominate factor affecting the electrical performance of LTPS TFT devices. Reducing the occurrence of grain boundaries by excimer laser grain controlling process [8.1]-[8.3], other crystallization method such as sequential lateral solidification process [8.4] has attracted much attention recently. These techniques apply to eliminate the grain boundaries from the active area of the TFTs, providing an excellent performance and better uniformity to integrate system circuits.

(3) In the AMOLED pixel design section, the p-type driving TFT has the power

line voltage drop issue while p-type driving TFT has the electrical variations of OLEDs issue. Developing a novel pixel circuit that the current flow through OLED is independent of power line and characteristics of OLED is important.

(4) Reducing the system cost and possessing compact module have become the main purpose of system on panel. Design consideration of level shifter towards low swing voltage range promoting high swing voltage range with simple structure and low power. In the system aspect, DC/DC converter is used to generate high voltage level by charge pumping circuits. Effectively reducing the overall power loss and voltage drop in charge pump circuit which means enhance its power efficiency has high priorities in designing. In the integrated driver part, analog buffer must be designed to pass through the right data without variation effect under high definition display. For further precisely output performance, 8mV deviation of analog buffer is necessary for the 256 gray scale display. For future applications, the maximum deviation of CPU nominal voltage is ±3%. Hence, novel crystallization technologies to eliminate the grain boundaries from the active area of the TFTs are required.

Last by not least, it is my belief that system on panel is not the only glorious target to pursuit; it must be considered “performance” and “cost”. It is essential to strike balance between performance and cost. Precise modeling and post-simulation after layout must be concerned during simulation steps to obtain accurate results.

(5) About the added-value applications, flat panel image sensors have gained much attention in medical applications. Crystal Si, amorphous Si, or poly-Si serves as the fundamental element of the readout circuit belonged to the pixel sensors [8.5]-[8.14]. The active pixel sensor performs in situ signal amplification providing higher immunity to external noise, hence preserving the dynamic range [8.5]. Conventional a-Si:H TFTs are limited by their low field-effect mobility (usually < 1 $cm^2/V*s$), and hence have poor performance for analog signal amplification. On the

other hand, poly-Si TFTs have high mobility (usually > 100 $cm^2/V*s$), but suffer from unacceptable large off state currents. Large leakage current is a problem in LTPS TFTs due to the abundant grain boundaries in the active channel. For the readout circuit or active pixel circuit application of the image sensor, low leakage current design is needed for further study. The signal will be disturbed by the noise since the large leakage current from poly-Si TFTs. To have excellent and high definition sensor array in added-value display, reduce the leakage current effect in the readout circuit towards design architecture or device structure will be an important topic.