Chapter 5

Summary and Conclusions

Low-temperature polycrystalline silicon thin film transistors (LTPS TFTs) were adopted as the main pixel switching and driving elements in this work due to the higher driving capability and the opportunity for integration of data drivers. The conventional pixel design has been studied and investigated in detail. In this thesis, new pixel circuits for driving organic light emitting diodes have been proposed. Improvements of the brightness uniformity have been achieved by diode connected concept in the pixel in order to compensate the electrical characteristic variation in TFTs.

In chapter two, all the compensation pixel circuits are introduced and discussed in detail. These pixel designs can be divided into three major driving modes including digital driving, analog driving, and novel driving. Each kind of circuit designs has its own advantages and disadvantages. Although digital driving method can produce accurate color, it is difficult for this method to be applied to high resolution products. Analog driving method can be divided into voltage programming circuits and current programming circuits according to the external applied signal source. Even though current programming circuits can compensate the threshold voltage and mobility variation at the same time, the driving speed is too low due to the large capacitance in the data line. Voltage programming circuits are more attractive to integrate poly-Si TFT data drivers on the display panel. Novel driving method can also achieve uniform brightness across the panel by the comparison between the sweep voltage and signal voltage in order to control the duration of luminous state.

In chapter three, dimensional effects of transistors and storage capacitor on the circuit characteristics have been studied and investigated in detail. The effect of slicing layout of circuit is also investigated by simulation and experimental results. In the traditional circuit design with two transistors and one capacitor, switching TFT is employed only as a switch element, so the dimension of the switching TFT is not an important factor in the circuit and can be reduced to the minimum design rule. Driving TFT plays a main role which will determine the current flow for OLED device. The larger of the driving TFT size, the larger of OLED anode voltage but the more area driving TFT occupies. The function of storage capacitor is to maintain the necessary data voltage of driving TFT during the whole frame period. Although larger capacitor can hold the data voltage effectively, the charging time and the aperture ratio of the display will decrease consequently. Due to the transistor slicing of driving TFT, the slicing layout can promote the driving capability to obtain the higher brightness for display and the anode voltage of OLED can be raised above 30% at Vdata=3V by experimental results. Therefore, the non-uniformity problem introduced during the fabrication process can be reduced 20% off effectively.

In chapter four, new voltage programming pixel designs for AMOLED consisting of five n-channel TFTs, one capacitor and one OLED have been proposed to obtain uniform brightness image across the panel even in the presence of spatial variation of threshold voltages. Besides the necessary scan line, only one additional control signal was used. The proposed circuit designs successfully produced almost identical output OLED current regardless of threshold voltage variation in TFTs. By experimental results, the non-uniformity can be suppressed to less than " 10% " in the proposed circuit. By means of using modified pixel design which replaced a n channel TFT with a p channel TFT in order to block the current flow path through OLED during pre-charge period, lower power consumption can be obtained. These pixel circuit designs can be considered for the AMOLED panel application in the future.