# Design and development of flexible organic devices for integration in high efficient circuitry

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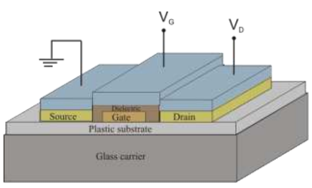
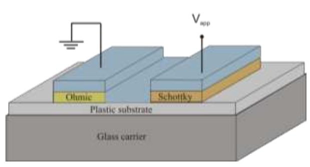
Organic Electronics is a rapidly emerging technology for flexible, high volume and low-cost systems. The scope for application such as in Radio frequency identification tags [1, 2], smart objects [3] and sensors [4, 5], broadens with the possibility of producing high efficient circuitry, through the integration of various electronic devices such as the organic thin-film transistor (OTFT), capacitor and Schottky diodes on a same flexible substrate.

This talk will focus on the various aspects in the development and integration of high performance OTFTs and lateral Schottky diodes built on a same substrate. The respective structures of the devices are as shown in Fig. 1, which consists of a bottom gate with bottom contacts configuration. Such a structure allows for ease of deposition and isolation of the ever-evolving organic semiconductor.




(a)




(b)

Fig. 1: Structure of (a) self-aligned gate OTFT and (b) lateral Schottky diode, using bottom-gate with bottom contact configuration.

The isolation of the active regions is vital in reducing the cross-talk and leakage paths between the devices, as demonstrated in the current-voltage characteristics of the Schottky diode in Fig. 2, measured in ambient condition. Upon isolation of the active region, the off-current reduces by three orders of magnitude, with a small change in the on-current, thereby enhancing the on/off ratio.

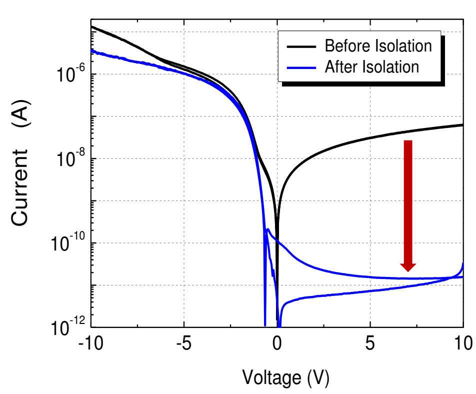
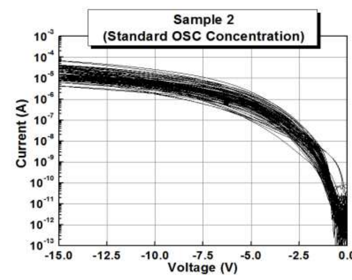


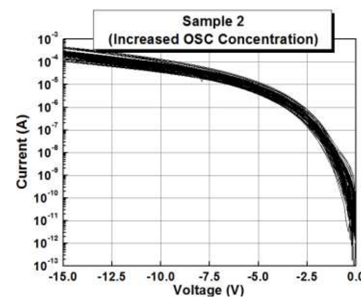

Fig. 2: Current-Voltage characteristics of the Schottky diode prior and after isolation of the active layer. The off-current reduces by several orders of magnitude.

In order to maintain compatible and simpler processes for the different devices, p-type organic semiconductors only are utilized. The circuit designs subsequently are also based on a pseudo-PMOS configuration rather than the conventional CMOS, validated with the aid of developed novel analytical device models [6, 7].

One of the key challenges in developing high performance circuits is the issue of parameter spreads of the devices built on the same substrate. Such spreads can be minimized through optimization of the processes. Figure 3 shows the current-voltage characteristic of 47 diodes built on the same substrate. With optimization of the processes, less variation in the on-currents and turn-on voltages are observed as in (b) compared to (a).




(a)




(b)

Fig. 3: Current-Voltage characteristics of Schottky diodes (47 diodes) measured across the same substrate. The variance in performance is reduced from (a) to (b) with optimization of the processes.

Finally, in order to enhance the overall performance and yield of the functional devices/circuits, the parasitic capacitances such as the crossover and overlap capacitances need to be minimized. The later is achieved by using a using self-aligned gate for the OTFT as represented in Fig. 1.

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