

Roll-to-Roll Processable OTFT Sensors and Amplifier

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Abstract:

The high flexibility and relatively low cost of organic electronics are gradually providing more possibility for their application. Compared with conventional silicon based electronics, organic electronics have relatively short lifecycles and processor speed, but they are more promising in the market of wearable and flexible devices, for example, wearable health care devices, simple memory devices and flexible displays. In recent years, some flexible and wearable sensors have been developed, e.g. skin-touching sensors embedded in a sports suit can detect the change of heart rate, blood pressure, ion concentration of perspiration, or infrared radiation from the human body.

In most sensors based on organic thin film transistors (OTFT) made to date, the semiconductors are employed directly to detect analytes. However, (1) the lifecycles of this design is short due to the low stability of organic semiconductors; and (2) any modification for selectivity needs to be compatible with the semiconductor.

In this paper, we present sensors based upon an extended floating gate in order to separate the sensory area from the semiconductor. Transistors are manufactured, using our roll-to-roll vacuum webcoating facility, using a high-throughput all evaporation process (Ding et al., 2016). We have demonstrated the principle of operation of a floating gate sensor integrated with the vacuum-deposited OTFT, by means of a simple strain sensor, using ferroelectric PVDF on the extended floating gate to directly act as a sensory material (Fig 2). To amplify the sensor signal further, a series of current mirrors and differential amplifiers have been designed based on the properties of single OTFTs. The combination of organic amplifier and OTFT sensor will be helpful to transduce sensing signal to a suitable level for wireless signal reading from flexible devices.

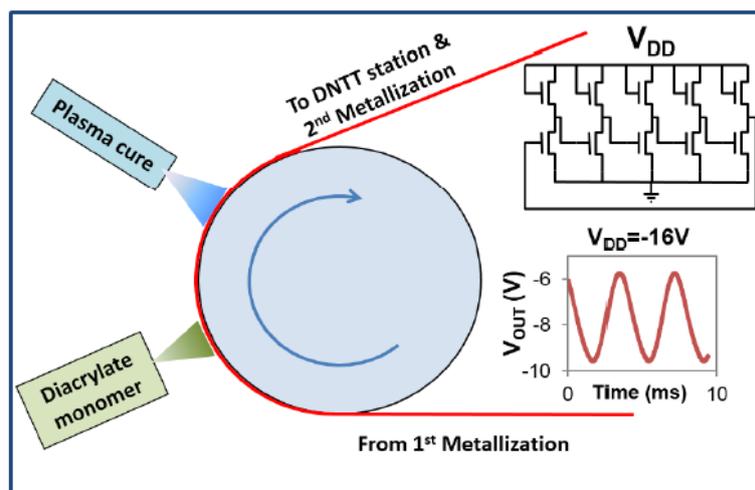


Figure 1. Schematic of R2R process to manufacture inverter (Taylor et al., 2015)

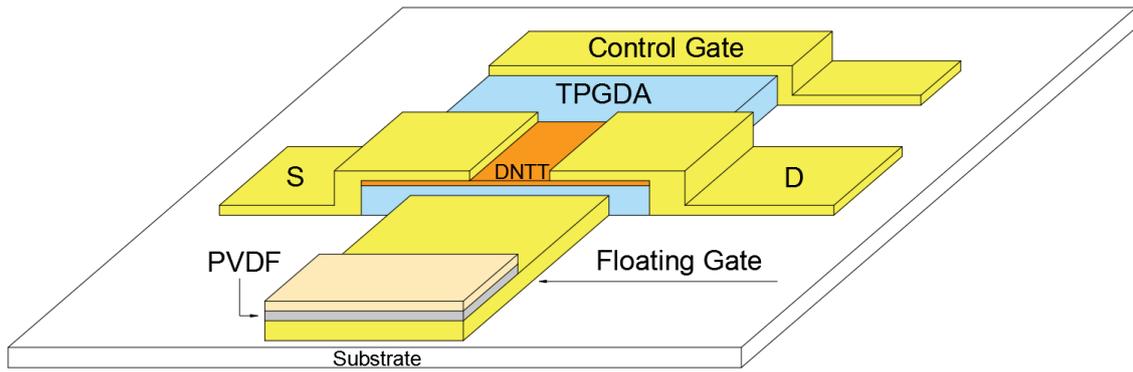


Figure 2. PVDF strain sensor based on floating gate OTFT

Reference:

- DING, Z., ABBAS, G. A. W., ASSENDER, H. E., MORRISON, J. J., YEATES, S. G., PATCHETT, E. R. & TAYLOR, D. M. 2016. Vacuum production of OTFTs by vapour jet deposition of dinaphtho[2,3-b:2',3'-f]thieno[3,2-b]thiophene (DNTT) on a lauryl acrylate functionalised dielectric surface. *Organic Electronics*, 31, 90-97.
- TAYLOR, D. M., PATCHETT, E. R., WILLIAMS, A., DING, Z., ASSENDER, H. E., MORRISON, J. J. & YEATES, S. G. 2015. Fabrication and simulation of organic transistors and functional circuits. *Chemical Physics*, 456, 85-92.