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Flexible Printed Sensor Tape to Diagnose Brain Injury

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Abstract

Sensors, electronics and memory are integrated to form a flexible device to monitor events that may cause brain injury. Thin film transistors are the building blocks of the control electronics and are based on solution processed materials, such as organic semiconductors and metal nanoparticles.[1] The availability of p and n-type organic semiconductors, shown in Figure 1, enables us to use printed CMOS circuits to ensure low power consumption.

The Palo Alto Research Center (PARC) is conducting a technical program to develop and prototype flexible sensor tapes to detect the occurrence of events that cause traumatic brain injury (TBI). TBI is a medical condition that is cumulative and triggered by events such as blast pressure waves, noise and acceleration. We are targeting fabrication techniques that would lead to low cost disposable tapes. Inkjet printing, laser machining and lamination are employed with all deposition and patterning steps being compatible with roll-to-roll manufacturing. The sensor tape has integrated sensors, signal conditioning electronics, non-volatile memory and a thin film battery. Our design uses multiple sensors for each sensing parameter in order to reliably collect the data associated with blasts. The sensors are based on piezoelectric polymers such as PVDF due to low-power requirements, low drift and relatively simple fabrication. The availability of n and p-channel solution-processed semiconductors enables the fabrication of complementary circuits which have the advantages of lower power consumption and simpler design compared with unipolar circuits. We characterized the charge trapping rates for n- and p-channel devices and assessed the inverter gain and noise margin.[2] The inverters showed a typical gain of 8 with V_{DD} at 10V and -3dB cutoff at 150 kHz for a load of 0.02pF.[3] The analog memory is non-volatile, based on TFTs with piezoelectric material as the gate dielectric and addressed as an active matrix array. We will discuss the memory design and the parameters that influence voltage operation and data retention time. In this talk we will focus on the main challenges of the program: materials performance, TFT voltage operation, and inkjet printing as a manufacturing technology.

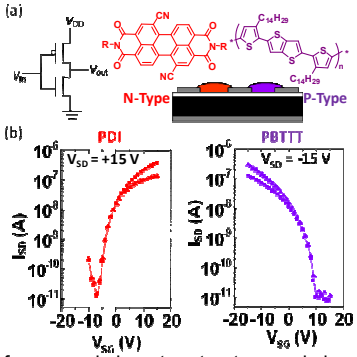

Figure 1. (a) Schematic and cross-sectional views of an organic inverter structure and chemical structure of PBTTT (p-type) and N1400 (n-type). (b) Transfer and output characteristics of the complementary OTFTs.

References

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