

Systems, Applications & Testing

Stanford Univ.:
An artificial skin built on organic transistors

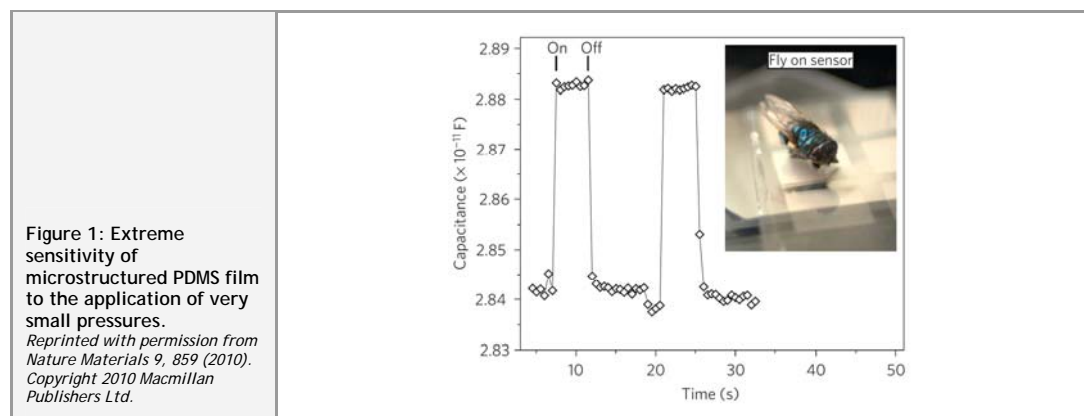
G. Horowitz

Within touch
of artificial skin



The group of **Zhenan Bao** at **Stanford University** has demonstrated a highly sensitive organic electronic-based artificial skin. Earlier demonstration of an artificial skin made of large arrays of pressure sensitive pixels has been published by the group of **Takao Someya** at the **University of Tokyo**. In this work, the heart of the sensor consists of the elastomeric polymer polydimethylsiloxane (PDMS). The key point was to structure the polymer film with pyramids disposed at regular intervals. The structure was realized by casting a dilute solution of PDMS and a cross-link agent into a silicon mould. The first step of the demonstration was to test the sensitivity of the PDMS (polydimethylsiloxane) structure by measuring its capacitance change upon application of a small pressure. As compare to the non-structured film, the sensitivity was increased by a factor of 30. Then, transistors were fabricated following a bottom-contact, top-gate architecture with the structured PDMS films acting as the gate dielectric. The semiconductor consisted of small rubrene single crystals deposited on pre-patterned gold source and drain electrodes. The substrate was rigid silicon, but flexible plastic substrates have also been used. The top gate electrode was made by laminating an ITO-coated PET film on top of the PDMS layer. The sensitivity of the sensor was demonstrated to be as low as a few kilopascals, which corresponds for instance to the pressure change on placing or removing a fly on the sensor.

The idea of using sensors pixels monitored by organic transistor to realize an artificial skin is not new. What is really innovative here is the sensitivity (and also the response speed) of the new device. There are two features that can account for this accomplishment. First, the use of a structured rubber film to realise the pressure sensor, which, as stated above, results in a significant improvement of the sensitivity. Second, the pressure sensor is here directly integrated into the transistor structure, thus improving the response time.



This work probably represents a significant advance towards the realization of artificial skins. However, two reservations on the possibility of future developments of the device can be emitted. First, the use of rubrene single crystals as semiconductor elements based on the technique developed by the group of Zhenan Bao does not seem to have been reproduced by other research group. Demonstrating the feasibility of the concept with more common organic transistor structures (e.g., devices made of polythiophenes) would certainly be more convincing. Second, at the time being, the device operates at high voltages (up to 80 V). A practical artificial skin would need lower voltages.

"Highly sensitive flexible pressure sensors with microstructured rubber dielectric layers" ; S.C.B. Mannsfeld, B.C.K. Tee, R.M. Stoltenberg, C.V.H.H. Chen, S. Barman, B.V.O. Muir, A.N. Sokolov, C. Reese, Z. Bao : *Nature Materials* 9, 859 (2010).