SYSTEM INTEGRATION THEME

Integration of Printed Electronics with Silicon for Smart Sensor Systems (iPESS)

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Low cost smart integrated sensors are an important element of emerging technology trends, such as the Internet of Things, wearable electronics or personal health monitoring. They are needed to record vital physical, chemical or biological signals and parameters and have to be integrated into a broad range of environments ranging from buildings to human bodies with full internet connectivity.

The vision of the iPESS project is that these sensors are best realised using a hybrid technology approach, combining commercial small-size silicon microelectronic chips for complex data processing and communication tasks with printed electronic components for the sensors and the signal conditioning of the sensor outputs. This is particularly appropriate for applications where multiple sensors that can't be easily miniaturized are distributed over a relatively large substrate area. Our approach aims to realize such smart sensors in new mechanically flexible form factors and at low cost. The iPESS project is developing the key building blocks for such hybrid sensors.

Our overall ambition is to be able to integrate the printed sensors with the analogue front end to develop a cost-effective integration platform for integrated sensor systems. Although our focus in the iPESS project is on gas sensors, the technology is applicable to a broad range of sensors and sensor arrays, including physical or biological sensors, and we welcome engagement with partners interested in a broad range of sensing applications.

In the past year, the project team in Manchester has developed a digital printing process for the fabrication of arrays of low-voltage organic FET sensors operating at voltages of <5V on a plastic substrate (Figure a). Chemical specificity will be achieved through the combination of different organic semiconductors on the array, each of which with a distinct response to the gaseous analyte to be detected. For the integration of different semiconductor materials onto the array we are using printing techniques.

The Cambridge team has focussed on developing an integration process for a printed analogue amplifier on a flexible substrate. To achieve a sufficient amplifier gain, we are combining high mobility p-type organic FETs with n-type, solution-processed oxide TFTs into complementary circuits (Figure b and c). For this we have developed a simple fabrication process for integrating these different materials onto a common plastic substrate.

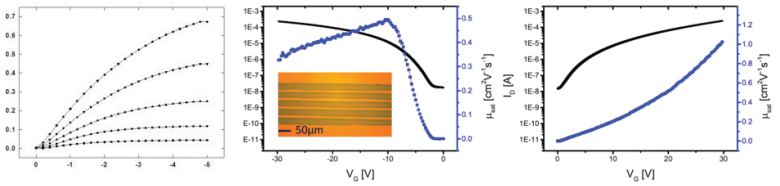

Figure a **Figure b** **Figure c**

Transistor device characteristics for printed sensors and analogue circuits: (a) characteristics of low-voltage printed FET sensor; characteristics of p-type organic; (b) and n-type oxide TFT (c) for integration into analogue amplifiers.

Project objectives

- an array of printed field-effect transistor (FET) sensors with high chemical specificity, initially for gas sensing applications (lead partner: University of Manchester)
- a printed electronics analogue frontend that provides adequate signal amplification and signal conditioning for the sensor signal to be