Flexible QVGA Active Matrix Displays based on Organic Electronics

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INTRODUCTION

Organic electronics, i.e. using an organic material as semi-conductor, opens the way to flexible displays using plastic substrates. This has been demonstrated for displays based on liquid crystals[1] and electrophoretic ink[2]. Here we demonstrate the use of an organic semi-conductor and an organic insulator, both applied from solution, in highly flexible active matrix QVGA displays, as well as the realization of logic functions in integrated circuits.

TECHNOLOGY

Bottom gate thin film transistors (TFT), of which the layout is shown in Figure 1, are used. These devices are processed on 150 mm diameter, 25 µm thick polyethylene naphthalate (PEN) films laminated on a removable support. The gold layers are structured using standard photolithographic techniques, since these give the possibility to fully exploit the mature production equipment used in the established IC and AMLCD industry. The gate dielectric is a 350 nm thick photo-structurable polymer (polyvinylphenol), which is applied by spincoating and is subsequently exposed to UV light to define contact holes.

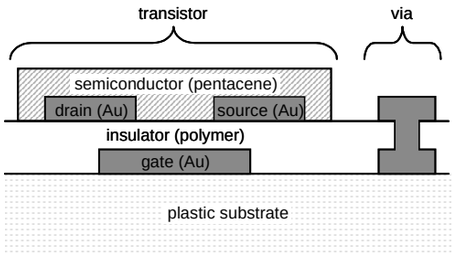

Figure 1 Cross section of a TFT and a vertical interconnect (via).

After structuring the second gold layer, a 100nm thick precursor pentacene film is applied by spincoating. Synthesis of this precursor and its conversion to pentacene is described elsewhere[3]. The semiconductor is subsequently patterned using a subtractive lithographic process. This completes the fabrication of the back plane. To make a display out of the back plane, an electrophoretic foil is laminated on top of it.

RESULTS

Devices made using the technology mentioned above have an average field effect mobility of 0.01 cm²/Vs at a gate bias of –20V. An impression of the uniformity of the mobility as measured on an active matrix back plane is given in Figure 2. The current modulation, measured between a gate bias of 0V and –20V, exceeds 10^6.

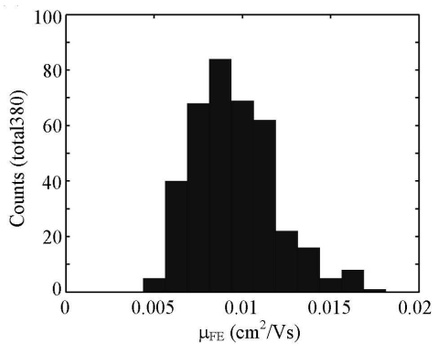

Figure 2 Distribution of the mobility on a QVGA active-matrix back plane based on measurements of 380 pixel TFTs, extracted from the transfer characteristics for V_{GS}=-20V and V_{DS}=-1V.

The current status of our technology is demonstrated by the QVGA display (240 rows and 320 columns) shown in Figure 3. Here the back plane is combined with an electrophoretic foil provided by E Ink Corp.

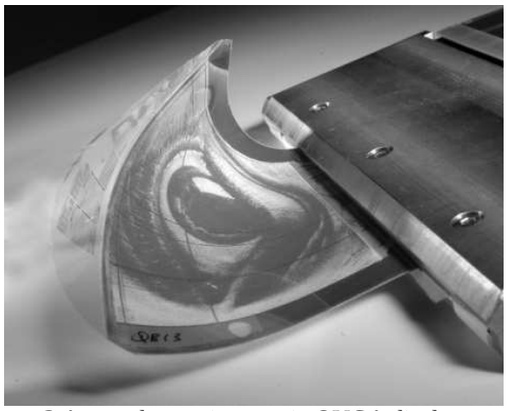

Figure 3 A complete active matrix QVGA display.

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