Collaborative project (IP) COSMIC
Complementary Organic Semiconductor and Metal Integrated Circuits
FP7-ICT-2009-4, GA-Nr. 247681

Newsletter March 2012

Analyzing yield and performance requirements for integrated circuits in organic electronics

For every application there are a set of minimum performance requirements which need to be met; otherwise the potential product has no practical and commercial value. COSMIC therefore not only address the improvement of the technology but asses how close the technology performance is to product requirements.
Let's look at two of the possible application for flexible electronics – a passive RFID tag and a line select for a roll able e-ink display. The system specifications have been given by the industrial partners of COSMIC. In the case of the RFID tag, friendly technologies suggested as the minimum requirements an HF silent tag with at least 32bit and with a pulling speed of 10tags/s. For the line driver, Polymer Vision, suggested to focus on at least QVGA e-ink display1.
Without looking too much on specific circuit design and process flows, we have chosen a few key technology parameters and translated the system requirements into those technology parameters as can be seen in the table below. In addition, we have added those technology parameters from a fully lithography defined COSMIC wafer-to-wafer manufacturing platform2 which shows the highest performance but has the disadvantage of higher cost.

	QVGA line select for e-ink display	32 bit HF-silent tag	W2W imec/TNO
yield of single OTFT (hard faults) [%]	99.97	99.5	>99
sigma V_T [V] (soft faults)	0.4	0.5	σ V_{TN}=0.15V σ V_{TP}=0.55V
stage delay	<2us	<0.5ms	5us@L=5um
overall area vs. footprint of inverter [mm^2]	<2000 <0.1	<2500 <5	0.08
supply voltage [V]	40	<20	>5

Table 1. Application requirements vs. technology performance

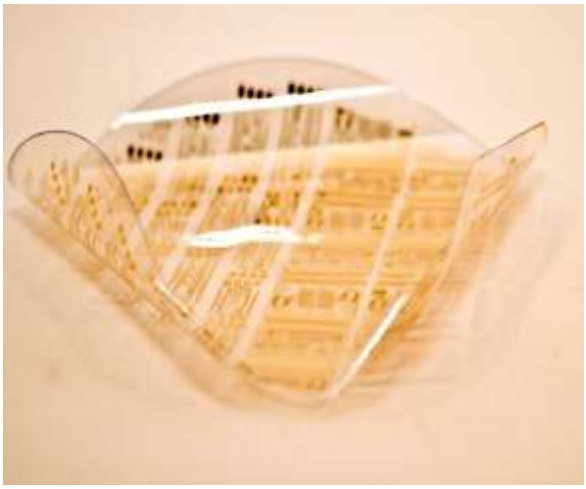


Figure 1. 6" wafer with plastic circuits in W2W manufacturing platform

Yield is the biggest challenge. Some of the lessons learned by the microelectronic industry over the last 40 years need to be applied again - preventing particle by e.g. using clean rooms, filtering solutions or reducing the footprint of the circuits will be essential. More work needs to be done on reduction in parameter spread which is tightly linked to issues such as thickness uniformity in deposited layers, control of the crystallization of semiconductor or straightness of metallization lines. That is why the main focus of COSMIC is on complementary logic. This allows an increase in acceptable parameter spread by more than factor 2 compared to simple unipolar logic 3. Finally, work is ongoing to improve the speed which to some extend is related to new high performance semiconductor but even more too high pattern resolution and high aligning accuracy. Only if all those challenges are met at

sufficiently low cost will there be an organic and flexible electronics industry. The COSMIC project is actively chartering the way.

For more information see
www.project-cosmic.eu

1. *Gerwin Gelinck , Paul Heremans , Kazumasa Nomoto ,* and *Thomas D. Anthopoulos,* Organic Transistors in Optical Displays and Microelectronic Applications, *Adv. Mater.* 2010, *22*, 3778–3798
2. Kris Myny, Soeren Steudel, Peter Vicca, Monique J. Beenhakkers, Nick A.J.M. van Aerle ,Gerwin H. Gelinck , Jan Genoe, Wim Dehaene , Paul Heremans, Plastic circuits and tags for 13.56 MHz radio-frequency communication, Solid-State Electronics 53 (2009) 1220–1226
3. 2. D.Bode et al, Noise-margin analysis for organic thin-film complementary technology, IEEE Transactions on Electron Devices, Vol. 57, (2010)

COSMIC Summerschool & Workshop 2012

Besides its research efforts the COSMIC consortium organizes different events for dissemination of project results on a regular basis.

Our next event is a cooperation of 4 EU projects: Interflex, Polaric, Smart-EC and COSMIC. It will offer presentations as well as hands-on practice with current processes in the field of printed electronics. The workshop targets engineers active in organic and large area electronics as well as students interested in this field.

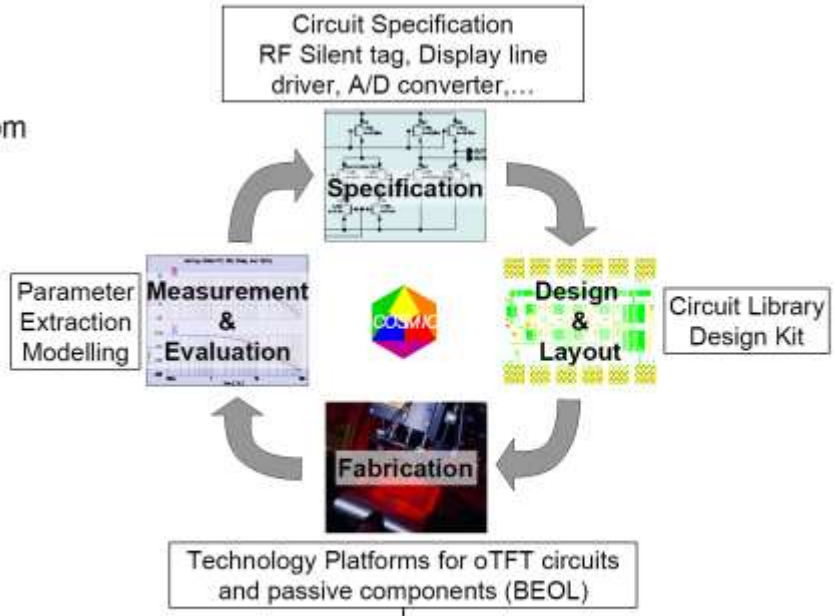
The workshop is hosted by Fraunhofer Institute EMFT in Munich and takes place in calendar week 26 at the end of June in 2012.

Supporting EU projects:

SMART-EC **Interflex** COSMIC POLARIC

The collaborative project COSMIC

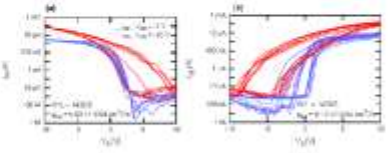
- generates a technology platform for organic electronics
- covers organic electronic applications from flexible complex, large-area to low-cost circuits
- targets complementary organic thin film transistor logic with p- and n-type oTFTs
- addresses the chain from design to manufacturing level
- optimizes process robustness to increase integration density
- sets up circuit modelling and design libraries
- includes digital and analog circuits as well as passive components
- will demonstrate technology with major lead applications



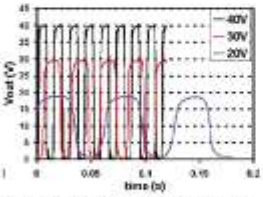
Foil on Carrier (W2W)
Ø150 mm foil on carrier
Clean room
Complex organic circuits

Sheet to Sheet (S2S)
320x380 mm sheets
Printing processes
Large area circuits

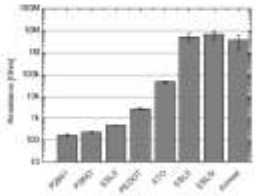
Roll to Roll (R2R)
210mm web
inline processes
Low-cost circuits



Statistics on p- and n-type oTFTs



Oscillation of ring oscillator with complementary inverters



Resistors printed with different carbon pastes

Project partners:
Fraunhofer EMFT (D)
CEA (F)
ST Microelectronics (I)
TNO (NL)
TU Eindhoven (NL)
IMEC (B)
Università di Catania (I)
CNR (I)
TU Berlin (D)
Friendly Technologies Ltd. (UK)
Flexink Ltd. (UK)
PolymerVision B.V. (NL)

Duration:
1.1.2010 - 31.12.2013

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