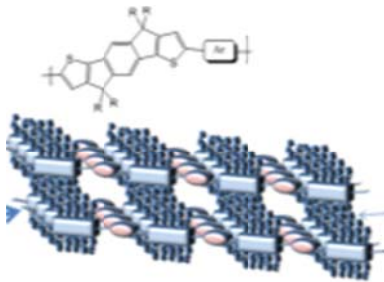


### Project COSMIC Pushes Forward Organic and Large-Area Electronics

With the final review in July 2014 one of the major European research projects on organic electronics has been finalized. With its results on organic thin film transistor and integrated circuit technology it provides a major contribution for the technological evolution in flexible, organic and large-area electronics.



*Organic semiconductor material (Flexink)*

Since discovery of organic semiconducting materials there have been numerous efforts to build up a new application field besides conventional electronics. Opposite to circuit technology mostly based on silicon, the organic semiconductor inherently enables usage in highly flexible systems and can be processed and patterned with low-cost printing processes. For this future application areas are seen in high-volume low-cost products (e.g. RFID circuits) and bendable devices (e.g. rollable displays). However implementation into products is still lacking because of performance and problems in achieving stable and reliable fabrication. For this the COSMIC project has been launched to bring integration of organic electronics on a technology level that allows circuit integration on plastic films in flexible and large area fabrication. RF tags (silent tags), display line driver, A/D converter and ALUs are targeted as lead applications to demonstrate the progress in manufacturing technology.

Technology development has been carried out on three different manufacturing platforms representing the different complexity and volume requirements in organic electronics. All of them are using flexible plastic films as substrate, but for very complex integrated circuits, like a line driver, a carrier based handling method is used, which forms the so-called wafer-to wafer (W2W) platform. On the other hand, for applications aiming at simple, but very large volume electronics a roll-to-roll (R2R) platform and in-between a platform working sheet-to-sheet (S2S) have been investigated



*Substrate processed with imec's carrier technology*

With their W2W platform **IMEC** and **TNO** have taken over the demonstration task for the line driver, where they used their process flow for evaporated n- and p-type semiconductor to fabricate flexible display line drivers. A 32-bit line driver has been verified to be fully functional and being capable of driving a flexible OLED display. Also a correctly working arithmetic logic unit (ALU) with organic transistors has been achieved.

**CEA-LITEN's** S2S platform based on printing processes achieved another outstanding result within COSMIC. An organic analog-to-digital converter with 4 bits has been already completed in 2012. For the end of the project a silent tag circuit is integrated, which is already in its 4-bit-version a very ambitious and complex circuit with regard to implementation of analog parts, signal detection and number of logic gates. Although the full processed tag initially does not work as a whole, it could be shown that really large building blocks of the circuit with about 250 transistors are operating properly, including the receiver and the code recognition.



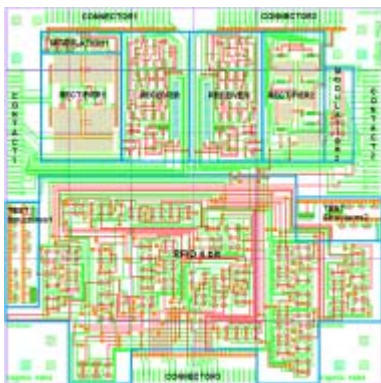
*Sheets processed on S2S platform of CEA-Liten*

Already this result clearly exceeds current state-of-the art in printed organic electronics and gives confidence that residual defects can be overcome in the near future.



*Roll of plastic film processed in the roll-to-roll application center of Fraunhofer EMFT*

**Fraunhofer EMFT** has re-focused its roll-to-roll technology towards applications with a cost structure that are compliant with a low-cost large-volume application. For this the development targets on an RF system that facilitates sensor readout by modulation of the carrier frequency. To overcome the existing roadblocks in its technology a newly developed material by the project partner **Flexink** has been tested with encouraging results, although process transfer has not yet succeeded to overcome existing limitations in process stability. However a major strength reached within the project is the roll-to-roll fabrication of passive elements like resistors, antennas and sensors.

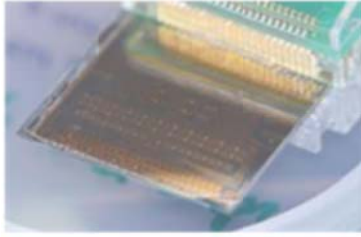


*Complex design of an RFID circuit  
(TU Eindhoven)*

An important element in the COSMIC development was the introduction of a mainly manufacturing oriented approach including modelling of transistor and circuit, which is incorporated in an initial design library. Several cycles of design, characterization and modelling have been carried out by **TU Eindhoven, University of Catania, CNR Rome** and **STMicroelectronics**. The partners in this work package extensively worked in innovative circuit design of digital and analog building blocks, considering also design solutions adapted to organic material limitations and processing variations. Modelling provided a thorough analysis of the contact effects in OTFTs. From these experimental results new model parameters were extracted and included in design toolkit for complementary OTFT circuits. Analog and digital building blocks are already implemented in a design library for CEA's S2S platform and can be offered to innovative designers for prototyping circuits on plastics.

In preparation of the planned demonstrators the industrial partners have worked out the system architecture for the planned circuits. Customized hardware platforms have been built, which allow to test the correct function of every lead application and to simulate an interaction between different lead application devices.

Finally the developments have been accompanied by reliability

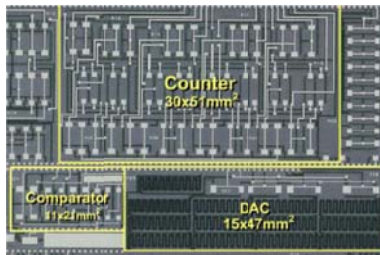


*Flexible display line driver  
(imec, TNO)*

investigations under the lead of **CNR**. Bias stress effects have been extensively studied and related to different phenomena.

The industrial partners also undertook research on the business potential of COSMIC applications. For this the markets of pure and custom printed silent tags (**Friendly**), printed line drivers (**Plastic Logic**) and other organic and flexible circuits (**ST Microelectronics**) have been explored. The industrial partners concluded that the potential market for the COSMIC applications is large and justifies the present and further R&D investment.

In summary COSMIC has moved organic electronics a truly big step forward both from an engineering and from a scientific perspective. There are still problems to solve but the project has well approached a point where this technology finds marketable applications, also beyond the classical lead applications.



*Flexible organic analog to  
digital converter (CEA)*

You can download the full final report [here](#).

Watch the videos on COSMIC results

- showing operation of organic analog-to-digital converter with printed temperature sensor. (*4BIT\_ADC.mp4*)
- showing operation of a 4-bit-adder built in organic thin film transistor technology (*4BIT\_ADDER.mp4*)
- demonstration of a QVGA OLED display with line drivers in oTFT technology (*LineDriver.mp4*)
- Prof. Cantatore explains setup for Silent Tag demonstration (*MVI\_Introduction Silent Tag to reader communication.mp4*)
- Humberto Moran shows demonstration of organic electronic in a »Silent Tag« (*MVI\_Demo transmission code from reader to tag.mp4*)