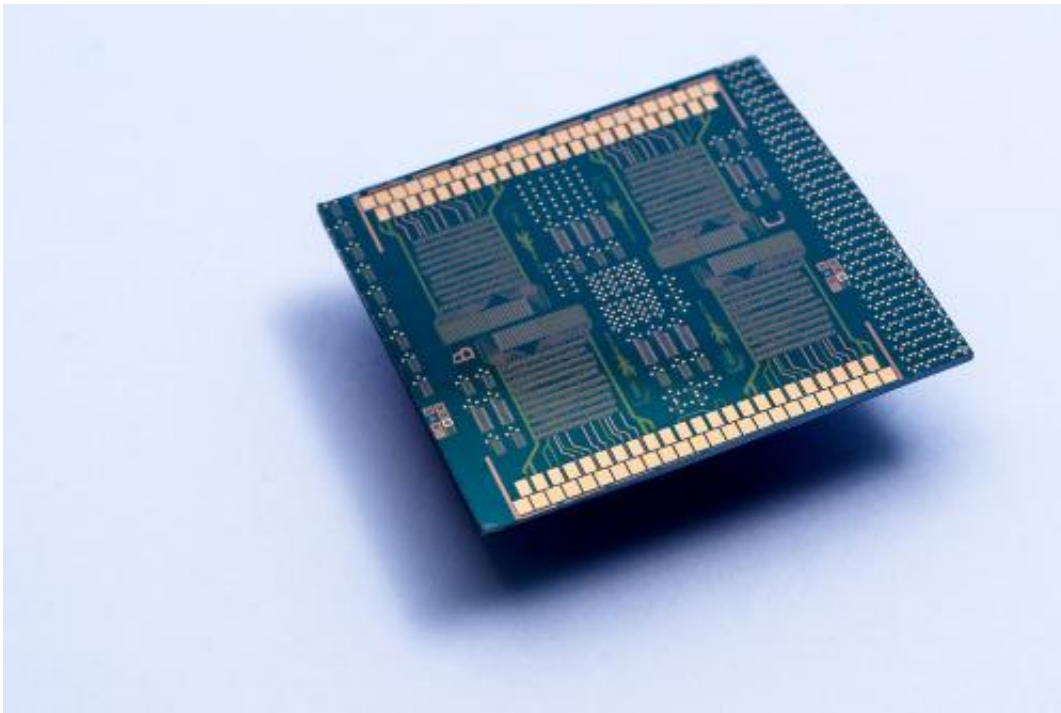


# Thin-film hybrid oxide-organic microprocessor

December 10 2014, by Hanne Degans

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Holst Centre, imec and their partner Evonik have realized a general-purpose 8-bit microprocessor, manufactured using complementary thin-film transistors (TFTs) processed at temperatures compatible with plastic foil substrates (250°C). The new "hybrid" technology integrates two types of semiconductors—metal-oxide for n-type TFTs (iXsenic, Evonik) and organic molecules for p-type TFTs—in a CMOS

microprocessor circuit, operating at unprecedented for TFT technologies speed—clock frequency 2.1kHz. The breakthrough results were published online in *Scientific Reports*, an open access journal from the publisher of *Nature*.

Low temperature thin-film electronics are based on organic and metal-oxide [semiconductors](#). They have the potential to be produced in a cost effective way using large-area manufacturing processes on plastic foils. Thin-film electronics are, therefore, attractive alternatives for silicon chips in simple IC applications, such as [radio frequency identification](#) (RFID) and near field communication (NFC) tags and sensors for smart food packaging, and in large-area electronic applications, such as flexible displays, sensor arrays and OLED lamps. Holst Centre's (imec and TNO) research into thin-film electronics aims at developing a robust, foil-compatible, high performance technology platform, which is key to making these new applications become a reality.

The novel 8-bit microprocessor performs at a clock frequency of 2.1 kHz. It consists of two separate chips: a processor core chip and a general-purpose instruction generator (P2ROM). For the processor core chip, a complementary hybrid organic-oxide technology was used (p:n ratio 3:1). The n-type transistors are 250°C solution-processed metal-oxide TFTs with typically high charge carrier mobility (2 cm<sup>2</sup>/Vs). The p-type transistors are small molecule organic TFTs with mobility of up to 1 cm<sup>2</sup>/Vs.

The complementary logic allows for a more complex and complete standard cell library, including additional buffering in the core and the implementation of a mirror adder in the critical path. These optimizations have resulted in a high maximum clock frequency of 2.1kHz. The general-purpose instruction generator or P2ROM is a one-time programmable ROM memory configured by means of inkjet printing, using a conductive silver ink. The chip is divided into a hybrid

complementary part and a unipolar n-TFT part and is capable of operating at frequencies up to 650 Hz, at an operational voltage of  $V_{dd}=10V$ .

Provided by IMEC

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