Technology and Design Kits for Printed Electronics

The goal of Technology & Design Kit for Printed Electronics (TDK4PE) is to set a fundamental change in the way printed electronics (PE) are designed and manufactured in Europe, with the aim of reducing costs and time-to-market by more than an order of magnitude for more complex designs than ever before by addressing thousands of transistors on a substrate.

GENERAL MOTIVATION AND OBJECTIVES

TDK4PE was built to offer to the printed electronics community a higher degree of design automation by building the set of tools and methodology to develop complex circuits and systems, which is a real requirement for a sustainable growth of the technology. Therefore, TDK4PE addressed the idea of how to abstract the Printed Electronics (PE) technology process details and identify the knowledge, methods and tools needed to design circuits for organic electronics emerging technologies without having to bear the entire burden of technology details regarding equipment, inks and substrates. This idea was already developed in the 80’s for the silicon industry by developing their related Process Design Kits (PDK) containing all technology related information for low end full-custom design, and Design Kits (DK) including libraries for cell-based semi-custom design.

CHALLENGE

At the beginning of the project, there was not any printed electronic process being offered publicly, so it is common in silicon or inorganic technologies, to widespread the advantages of the technology and open opportunity for applications. This was due to several reasons. As an immature industry almost all business models were vertical, providing in-house the complete solution from application to fabrication. Public funded institutions like technology centres, research institutions or universities have also technological processes oriented to research and prototyping (not to high productions) that could be ideal for feasibility studies. In these cases, the main reason for not opening them is their continuous evolution that avoids a stable public offer for a significant period of time.

WORK DESCRIPTION AND ACHIEVEMENTS

TDK4PE approach has been validated with 3 different organic electronics technologies capable of building OTFTs: full-inkjet, gravure and evaporation. Full-inkjet technology has been developed and validated in the project. Around 50,000 transistors and 17,000 DRC structures have been fabricated in a process that converged towards a balanced performance-yield goal provided by real applications (flexible textile systems for user interfaces). Semi-automatic characterization and analysis procedures and have been set-up to analyse huge amounts of data used for process optimization and model generation. The full-custom design kit for full-inkjet technology has been developed and validated whereas cell-based design kit could not be validated during the duration of the project. TDK4PE approach has also been validated using third party technologies showing the powerfulness of the approach towards a virtual foundry model. A full-custom design TDK has been generated for gravure printing provided by CSEM and validated by them. A full-based design kit has been produced and validated for an evaporation process (provided by CPI) and used for the characterization and modelling process developed in the project on 12700 transistors, 620 logic gates and 15000 DRC structures designed in the project and fabricated by CPI. The cell-based design kit for CPI could not be validated during the duration of the project.

The Institute of Telecommunications (IT) was involved in the electrical characterization of the individual transistors. IT played an important role in the optimization of the device fabrication procedures. This was achieved by providing continuous feedback the production lines about device performance. The team at the Institute of Telecommunications was also involved in the fabrication and test of one of the project demonstrators, a RFID tag full printed in a plastic foil. The printed RFID tag was able to operate at the frequency of 134 KHz.

Selected EDA tools have been MaskEngineer/ClawOn from Phoenix SoftwareTM and the open/free tools suite built around Glade. Technology independence has been achieved through the TDK4PE information structure (managed using XML descriptors) following the OpenAccess standard from the silicon industry and PDAFlow promoted by Phoenix SoftwareTM Ngspace electrical simulator has been primarily used (other spice versions have been validated) Verilog-A was selected as description language for device models.