PhD Project

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Title:
Design of electronic devices and circuits for sustainable IoT components.

Introduction:
Managing electronic waste is becoming an important ingredient of sustainability considerations for our future on this planet. The incoming deluge of novel IoT electronic components for pervasive, low-cost distributed sensing and monitoring applications in all sectors brings about serious concerns of a further exponential growth of electronic waste. The massive deployment of disposable electronics tags in agriculture and commerce foreseen by the precision agriculture roadmaps further aggravates the looming scenarios.
Recent developments of microelectronic technologies on flexible disposable/biodegradable/compostable and even edible substrates marks the start of a new pathway toward more sustainable electronic technologies based on materials different from Silicon or rare earth elements. Polycrystalline thin films, semiconducting oxides, and biopolymers represent interesting alternatives. The adoption of biocompatible materials in electronics is also key to innovate in the health and agrifood sectors. However, their adoption is seriously limited by either lack of adequate performance or lack of modeling and simulation tools suited to assist the engineers in designing demonstrator devices and systems with increasing complexity.

Proposed research activity and PhD thesis objectives:
The objective of the PhD thesis is to develop models and simulation tools to improve the performance and optimize electronic devices and circuits with biocompatible, degradable and compostable materials. Ad-hoc models in MatlaB/Python/Verlog A, commercial TCAD (SDevice), Multiphysics modelling frameworks (COMSOL) and circuit level simulators and commercial TCAD will be developed and demonstrated on the design of simple circuits in flexible substrates for applications in the health and agrifood sector. DC, AC, and transient operations will be considered to enable assessment of digital and analog performance metrics in various technologies. Model calibration will be pursued on measurements provided by partners in the IUNET consortium. Mixed-mode device-circuit simulations and Verilog A coding will be exploited to merge physics-based descriptions of the transistors and diodes to circuit level representations of the circuit. The activity will start taking IGZO devices and circuits as reference and then develop toward fully biodegradable/compostable materials.

Vision goals of the activity: The ultimate goals of the study are: 1) to develop simulation models calibrated on measurements, to predict the DC, AC and transient performance of advanced devices on flexible biodegradable substrates for disposable IoT; 2) to investigate the attractiveness of these new technologies up to the level of analog and digital circuit blocks by means of calibrated compact models assisting circuit design.

Supporting research projects (and Department)
The activity will be carried out at the DIEF, Università degli Studi di Modena e Reggio Emilia and may include a stage at a partner institution in Italy and Europe.

Possible connections with research groups, companies, universities.
IUNET Research Consortium (www.iunet.info) and specifically University of Bolzano, Venezia, Perugia.
IMEC research center (Belgium)
CEA Leti (Grenoble)