Summary
This course addresses the implementation of organic and printed electronics technologies using large area manufacturing techniques. It will provide knowledge on materials, printing techniques, devices, systems, and applications: state of the art and current status on commercialization.

Content
General introduction: What is printing? Historical background, Printed electronics and large area manufacturing: materials, processes, devices and systems, Unique aspects of printable electronics, Status in the field and trends.
Organic semiconductors: Introduction to organic semiconductors, From chemical bonds to bands, Charge injection and transport, Optical properties, Examples of relevant printable electronic and functional materials.
Electrons to light and light to electrons: OLEDs and OPVs: Introduction and history: organic light emitting diodes and organic photovoltaics, Basic device structures and operation, Processing: evaporation/ solution processing, lab to fab, sheet and roll processes, Packaging and encapsulation considerations, Figures of merit and relation to applications.
Energy storage and harvesting: Principles of battery and supercapacitors, architectures, printed of energy sources and storage components, Mechanical and thermal harvesters, rectennas.
TFTs and circuits: Introduction about printed transistors: organic/polymer, metal-oxide, electrolyte gated. CSEM's case studies: submicrometer OTFTs and gravure printed OTFTs, From transistors to circuits (modeling, design kit, technology assessment).
Heterogeneous integration and Smart systems: Introduction to integration methods: one Foil vs. Foil-to-Foil approaches, System in Foil, Hybrid integration: SMD and printed component on foil, CSEM’s case studies: high-pass audio filter and sun sensor, Passive components: Resistors, capacitors, inductors, Memories: Resistive, ferroelectric, write-once-read-many (WORM), RFID, wireless and smart systems.
Encapsulation: Introduction, relevance, encapsulation of large area printed / organic electronics, Permeation in solids and thin films, Examples of barriers materials and processing for different devices and systems, Characterization and evaluation of encapsulation.
Large area manufacturing of printed systems: Challenges: from small to large area, All printed vs. hybrid, Sheet to sheet vs. roll to roll, Examples of manufacturing lines, Characterization techniques for LAM, Environmental aspects.
Applications, commercial products and market, roadmap and innovation: Roadmapping: what is it?, Application examples (e.g. OLED, OPV, hybrid and integrated systems), Innovation management in printed electronics.

Keywords
Printed, flexible and organic electronics, large area manufacturing techniques, electronics, photonics, sensors and microsystems, energy sources and storage, encapsulation, heterogeneous integration, smart systems, industrial products

Learning Outcomes
By the end of the course, the student must be able to:

- Illustrate applications of functional and intelligent surfaces and smart systems fabricated using large area manufacturing
- Predict systems integration issues and propose methods for integration and encapsulation of printed devices and systems
- Identify the advantages, drawbacks, performances, complementarity and uniqueness of large area manufacturing vs. silicon technology
- Integrate the operation principles, architectures and processing of main devices and systems fabricated using printing techniques
- Analyze the challenges of manufacturing products using large area fabrication techniques
- Compose examples of pilot and production lines for printed electronics devices and systems

Teaching methods
Lectures, exercises, case studies

Expected student activities
Attending the lectures
Review the slides and read the reference book
Solving the exercises

Assessment methods
Oral examination at the end of the course

Resources

Bibliography
- Large Area and Flexible Electronics, Mario Caironi & Yong-Young Noh (Eds.), WILEY-VCH, 2015, 592 pp.

Ressources en bibliothèque
- Organic and Printed Electronics: Fundamentals and Applications / Nisato
- Introduction to Printed Electroncis / Suganuma
- Flexible Electronics: Materials and Applications / Wong
- Organic Electronics: Materials, manufacturing and applications / Klauk
- Organic Electronics II: More Materials and Applications / Klauk
- Large Area and Flexible Electronics / Caironi