

MICRO-505

Organic and printed electronics

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Cursus	Sem.	Type
Microtechnics	MA2, MA4	Obl.

Language of teaching	English
Credits	2
Session	Summer
Semester	Spring
Exam	Oral
Workload	60h
Weeks	14
Hours	2 weekly
Courses	2 weekly
Number of positions	

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.

Printing and other large area processes: Basics and fundamentals, Fluid formulation and rheology for printing, Ink-substrate interaction, Inks and printing techniques: gravure, flexography, screen, inkjet, Coating techniques, Laser processes, Additional coating and structuring techniques. Ink drying, curing and sintering: oven, UV, plasma, microwave, photonic techniques.

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.

Sensors and actuators: Printed sensors and Actuators, Chemical: liquid and gas phase, Biosensors, Physical sensors: temperature, pressure and touch, light, Microsystems and MEMS, Actuators, Lab-on-chip and microfluidics.

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

- Organic and Printed Electronics: Fundamentals and Applications, G. Nisato, D. Lupo, S. Ganz (Editors), CRC Press, 2016, 580 pp.
- Large Area and Flexible Electronics, Mario Caironi & Yong-Young Noh (Eds.), WILEY-VCH, 2015, 592 pp.
- Introduction to Printed Electronics, Katsuaki Suganuma, Springer 2014, 124 p.
- Flexible Electronics: Materials and Applications, W. S. Wong, A. Salleo (Eds.), Springer, 2009, 462 p.
- Organic Electronics II: More Materials and Applications, Hagen Klauk (Ed.), WILEY-VCH, 2012, 420 p.
- Organic Electronics, Hagen Klauk (Ed.), WILEY-VCH, 2006, 428 p.

Ressources en bibliothèque

- [Organic and Printed Electronics: Fundamentals and Applications / Nisato](#)
- [Introduction to Printed Electronics / Suganuma](#)
- [Large Area and Flexible Electronics / Caironi](#)
- [Organic Electronics: Materials, manufacturing and applications / Klauk](#)
- [Organic Electronics II: More Materials and Applications / Klauk](#)
- [Flexible Electronics: Materials and Applications / Wong](#)