MICRO-505

Organic and printed electronics

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Cursus	Sem.	Type
Microtechnics	MA2, MA4	Opt.
Neuro-X minor	E	Opt.
Neuro-X	MA2, MA4	Opt.
Photonics minor	E	Opt.
Robotics	MA2, MA4	Opt.

Language of teaching	English
Credits	2
Session	Summer
Semester	Spring
Exam	Oral
Workload	60h
Weeks	14
Hours	**2 weekly**
Lecture	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, Markets and applications, Status in the field and trends.
Organic semiconductors and Materials for large area electronic: Introduction to organic semiconductors, From chemical bonds to bands, Charge injection and transport, Optical properties, Examples of relevant printable electronic and functional materials.
Physics of printing and printing techniques: Basics and fundamentals, Fluid formulation and rheology for pritning, Ink-substrate interaction, Inks and printing techniques: gravure, flexography, screen, inkjet, Coating techniques, Additional coating and structuring techniques. Ink drying, curing and sintering: oven, UV, plasma, and photonic techniques.
TFTs and circuits: Physics and technology of organic and printed transistors, From transistors to circuits (modeling, design kit, technology assessment).
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, Large area manufacturing: evaporation/solution processing, Figures of merit and relation to applications.
Sensors and actuators: Printed and flexible sensors, Principles of operation, Chemical: liquid and gas phase, Biosensors, Physical sensors: temperature, pressure and touch, light, Microsystems and Actuators.
Integration and Smart systems: Introduction to integration approaches, Interconnection methods, Hybrid integration: SMD and components on foil Systems in Foil, In mold electronics, 3D structural electronics, Integrated smart systems.
Energy storage: Batteries vs. supercapacitors, Materials and components, Challenges in printing batteries and supercapacitors.
Encapsulation, products and applications: 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. Application and products examples (e.g. OLED, OPV, hybrid and integrated systems),
Sustainable and biodegradable electronics: How organic and printed electronics can contribute to more sustainable electronics, Transient electronics**,** Biodegradable materials and specific processes, Disposable, bioresorbable and paper electronics, End of life scenarios, Life cycle assessment.

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 Prerequisites

Recommended courses

Physics of semiconductors devices

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 exemples 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

Assessment methods

Oral examination at the end of the course (100%)

Resources

Bibliography

- Organic and Printed Electronics: Fundamentals and Applications, G. Nisato, D. Lupo, S. Ganz (Editors), CRC Press, 2016, 580 pp.
- Solution-Processable Components for Organic Electronic Devices, B. Luszczynka, K. Matyjaszewski, and J. Ulanski (Eds.), 2019, WILEY-VCH, 688 pp.
- Large Area and Flexible Electronics, Mario Caironi & Yong-Young Noh (Eds.), WILEY-VCH, 2015, 592 pp.
- Introduction to Printed Electroncis, 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, Lupo, Ganz
- Solution-Processable Components for Organic Electronic Devices / Luszczynka, Matyjaszewski, Ulanski
- Large Area and Flexible Electronics / Caironi, Noh
- Introduction to Printed Electroncis / Suganuma
- Organic Electronics / Klauk
- Organic Electronics II: More Materials and Applications / Klauk
- Flexible Electronics: Materials and Applications / Wong, Salleo

Moodle Link

- https://go.epfl.ch/MICRO-505