Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Introduction to printing technologies and flexible components
Course code	
Scientific sector	ING-INF01
Degree	PhD in Advanced Systems Engineering
Semester	2
Year	1
Academic year	2020/2021
Credits	3
Modular	No

Total lecturing hours	30
Attendance	Preferred
Prerequisites	None
Course page	None

Specific educational objectives	The course is a specialized course in the interdisciplinary area of physics, material science, chemistry, electronics, and biotechnology, addressing the implementation of flexible electronics technologies. It is designed to acquire knowledge in flexible electronics device technology, from materials, processes, devices to systems and applications: state of the art and current status on commercialization. The specific educational objectives are to: - Acquire basic understanding and knowledge of printing and microfabrication technologies. - Acquire basic understanding and knowledge of device characterization methods. - Acquire "practical" experience with different fabrication and characterization techniques.

Lecturer	Luisa Petti
Scientific sector of the lecturer	ING-INF01
Teaching language	English
Office hours	From Monday to Friday, on appointment
List of topics covered	1. Flexible electronics: general introduction - Historical background - Materials, devices, systems, applications - Fabrication techniques - Unique aspects, status in the field and trends

2. Thin-film microfabrication techniques
- Basics and fundamentals
- Deposition and structuring methods

3. Printing techniques
- Basics and fundamentals
- Fluid formation and rheology for printing
- Inks and printing techniques
- Additional coating and structuring methods

4. Alternative fabrication techniques
- Laser processing
- Additive manufacturing

5. Thin-film transistors and circuits
- Thin film transistors (TFTs)
    - Device operation, materials, and structures
    - Device characterization and performance
    - UNIBZ's case study: sub-micrometer Indium-Gallium-Zinc-Oxide TFTs and spray-coated carbon nanotube TFTs
- Thin film circuits
    - From transistors to circuits
    - Other passive and active thin-film components
    - Digital and analog circuits

6. Sensors and biosensors
- Sensors
    - Principles and fundamentals
    - Examples of flexible physical, chemical and optical sensors
- Biosensors
    - Principles and fundamentals
    - Examples of flexible biosensors

7. Actuators
- Principles and fundamentals
- Examples of flexible optical and thermal actuators

8. Energy harvesting and storage components
- Energy harvesters
    - Principles and fundamentals
    - Examples of flexible energy harvesters
- Storage components
    - Principles and fundamentals

	- Examples of flexible supercapacitors and batteries 9. <u>Further processing components</u> - Interconnections, antennas, memories 10. <u>Integrated Systems</u> - System integration strategies - Examples of fully flexible and hybrid systems 11. <u>Applications</u> - Examples applications from academia and industry - Roadmapping
Teaching format	Digital format (provided on teams) divided in: - Theoretical lectures using: - Slides - Videos (e.g., conference presentations, laboratory tutorials) - Practical exercises: - Use of softwares (e.g. Origin, Corel) for data analysis and plotting. - Projects & assignments: - Informal discussions on presentations and scientific papers - Preparation of short papers based on literature review

Learning outcomes	**Knowledge and understanding**: theoretical know-how on printing, microfabrication, and characterization technologies for electronic components. **Applying knowledge and understanding**: practical know-how on printing, microfabrication, and characterization technologies for electronic components. **Making judgments**: Capability of identifying the most suitable fabrication and characterization methods to realize specific electronic devices for a given targeted application. **Communication skills**: ability to give a specialized technical presentation supported by power-point slides. **Learning skills**: performing a literature review on a given topic; extracting the most valuable information and embedding it in a presentation.

Assessment	A project work developed by the student will be assessed:

	presentation and discussion of a topic related to the contents of the course agreed between lecturer and students.
Assessment language	English
Evaluation criteria and criteria for awarding marks	Quality of the presentation and engagement in the practical project.

Required readings	Assigned in class
Supplementary readings	Bibliography: - "Organic Flexible Electronics: Fundamentals, Devices, and Applications", P. Coseddu and M. Caironi, Elsevier, 2020. - "Organic and Amorphous-Metal-Oxide Flexible Analogue Electronics", V. Pecunia, M. Fattori, S. Abdinia, H. Sirringhaus, and E. Cantatore, Cambridge Elements, 2018. - "Organic and Printed Electronics: Fundamentals and Applications", G. Nisato, D. Lupo, S. Ganz, CRC Press, 2016. - "Large Area and Flexible Electronics", M. Caironi and Y.Y. Noh, WILEY-VCH, 2015. - "Flexible Electronics: Materials and Applications", W. S. Wong, A. Salleo, Springer, 2009.