

nanoSeminar Series 2022

Institute for Materials Science

Dr. Matteo Cucchi

Laboratory for Soft Bioelectronic Interfaces, EPFL, Lausanne, Switzerland

Organic electrochemical networks for biocompatible and implantable machine learning

Thursday, February 24rd 2022

13:00 – 14:00

Normal: Seminar Room 115, Hallwachsstr. 3 (HAL)

Pandemic version: <https://tinyurl.com/nanoSeminar-GA>

Early detection of malign patterns in patients' biological signals can save millions of lives. Despite the steady improvement of AI-based techniques, the practical clinical application of these methods is mostly constrained to an offline evaluation of the patients' data. Previous studies have identified organic electrochemical devices (OECTs) as ideal candidates for biosignal monitoring [1,2]. However, their use for pattern recognition in real-time was never demonstrated. I will show how OECTs can be employed to produce and characterize brain-inspired networks composed of polymeric dendritic fibers [3] and employ them for classification tasks[4]. The machine learning approach known as reservoir computing is ideal for such applications. For instance, analysis of heartbeats resulted in the classification of 4 classes of arrhythmic heartbeats with an accuracy of 88%. With the same architecture, biofluids e.g., blood, can be actively monitored. The aim of this study is to introduce a novel paradigm for biocompatible computational platforms and may enable the development of ultra-low power consumption hardware-based artificial neural networks capable of interacting with body fluids and biological tissues.

[1] Khodagholy et al., In vivo recordings of brain activity using organic transistors, Nature communications, 2012

[2] Rivnay et al., High-performance transistors for bioelectronics through tuning of channel thickness, et al. Science advances 1.4 (2015): e1400251.

[3] Cucchi et al., Directed Growth of Dendritic Polymer Networks for Organic Electrochemical Transistors and Artificial Synapses, Adv. El. Mat., 2021

[4] Cucchi et al., Reservoir computing with biocompatible organic electrochemical networks for brain-inspired biosignal classification, Science Advances, 2021

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Matteo Cucchi is a researcher at EPFL in Lausanne exploring design and fabrication routes for long-term brain implants for stimulation and recording. After working at the Institute of structure of matter (ISM) in Rome, Matteo Cucchi moved to TU Dresden in 2016 to pursue a Master in organic and molecular electronics. There, he carried out his doctoral work under Prof. Karl Leo where he worked on electrochemical networks for biocompatible platforms capable of pattern recognition and machine learning, graduating in 2021 with summa cum laude. He moved to EFPL in Lausanne in February 2022. He is an expert in organic electronic-ionic mixed conductors and organic semiconductors.