Embassy of Italy
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AIMES

SWETALY

A platform to discuss the new trends in the field of organic bioelectronics, by gathering scientists from the Italian and Swedish scientific communities working on innovative bioelectronic materials, devices, and their applications.

The scientific program covers among other topics: aspects of sustainable synthesis, alternative raw materials, advanced materials, unconventional device fabrication, and related applications in sensing, implantable devices, tissue engineering, and energy harvesting with the aim of fostering interaction and opportunities to strengthen the bilateral collaboration.

BIOELECTRONICS AND SUSTAINABILITY

26-27 OCT 2023

CAMPUS ALBANO, HOUSE 3, ROOM 4205

Albanovägen 29, Stockholm

26 October

Chair: **Luca Beverina and Erica Zeglio**

09:45 – 10:30 Welcome

10:30 – 11:00 Introduction and welcome note

11:00 – 11:30

Magnus Berggren – Substrate-free organic bioelectronics integrated with living cells and tissues

11:30 – 12:00

Simone Fabiano – Organic electrochemical neurons with ion-mediated spiking

12:00 – 12:30

Michele Di Lauro – Organic neuromorphic devices as buildning blocks for neuroelectronics

12:45 – 13:45 Lunch break

Chair: **Anna Herland and Luca Beverina**

13:45 – 14:15

Daniel Simon - Organic electronic biosensors for sustainable future healthcare

14:15 - 14:45

Luisa Torsi – Single-molecule bioassays for one-healthcare at the point of care

14:45 – 15:15

Eleonora Macchia – Single-molecule bioelectronic sensor: improving reliability with machine learning approaches

15:15 – 15:45

Beatrice Fraboni – Fully organic flexible detector for real-time dose monitoring during radio/proton therapy

15:45 – 16:15

Onur Parlak – Epidermal sensors for medical diagnostics

16:15 – 16:45 Coffee break

16:45 – 17:15

Fabio Biscarini – Organic neuromorphic devices for in-vitro diagnostics and in vivo neurophysiology

17:15 – 17:45

Maria Rosa Antognazza – Organic semiconductors for regenerative medicine: optical modulation of the cell fate

17:45 – 18:15

Maria Asplund – Why future bioelectronic medicine requires unconventional electrode materials

18:15 – 18:45

Mahiar Max Hamedi – Superstrong electronic hydrogel actuators (ECO)

27 October

Chair: **Sara Mattiello and Luca Beverina**

09:00 – 09:30

Guglielmo Lanzani – Organic phototransducers for abiotic/biotic coupling

09:30 – 10:00

Gianluca Maria Farinola – Living materials for optoelectronics from biopolymers and photosynthetic microorganisms

10:00 – 10:30

Eleni Stavrinidou – Plant bioelectronics for high-resolution monitoring and electronic control of plant processes

10:30 – 11:00 Coffee break

11:00 – 11:30

Mario Caironi – Recent progress in edible electronics and printed organic biosensors

11:30 – 12:00

Peter Andersson Ersman – All-printed organic electronic components and systems for sustainable (bio)electronic applications on flexible substrates

12:00 – 12:30

Erica Zeglio – Sustainable strategies for electrochemical transistor design

12:30 – 13:30 Lunch break

Chair: **Erica Zeglio and Sara Mattiello**

13:30 – 14:00

Christian Muller – Interplay of electrical and mechanical properties of doped conjugated polymers

14:00 – 14:30

Luca Beverina - Conjugated materials from and into interface-rich, water-based microheterogeneous environments. Introducing sustainability in organic electronics

14:30 – 15:00

Alexander Giovannitti – Next-generation polymeric organic semiconductors for electrochemical transistors in aqueous electrolytes

15:00 – 16:00

Round table discussion and closing remarks

16:00 – 17:00 Event closing

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Introduction

Welcome to the Italy-Sweden Bilateral Symposium on Bioelectronics and Sustainability (BEES).
This initiative brings together scientists working in the field of organic bioelectronics to explore the recent advancements and opportunities arising at the intersection of innovation and sustainability.

Over the past two decades, both Sweden and Italy have stood at the forefront of this exciting field, making significant contributions to the development and application of organic electronic materials at the interface with biology. These applications encompass a wide spectrum, including sensors for health and environmental monitoring, drug delivery systems, tissue engineering, and neuromorphic devices.

As our environmental awareness continues to expand, it has become increasingly evident that this field must play a pivotal role in pushing towards sustainable technologies. This extends from materials designed with inherent sustainability to unconventional device fabrication and device architectures that enable a circular approach.

The symposium brings together interdisciplinary scientists from Italy and Sweden, each engaged in diverse research areas but interconnected by the common thread of organic bioelectronics. Our objective is to provide a platform to exchange ideas and discuss the prospects and challenges of the forthcoming generation of sustainable organic bioelectronics – aimed at promoting resource conservation and minimizing waste generation. Participants' contributions encompass the next-generation of organic electronic materials, edible and printed devices, applications in healthcare and environmental monitoring, materials integration with living organisms, and devices end-of-life management.

This initiative is timely because addressing sustainability issues has become a fundamental aspect of policies in the European Union and globally, and we expect that sustainability considerations will play an even larger role in the future developments of this emerging field.

There are already many good examples of industries and initiatives that have embodied sustainable R&D in greener and more environmentally friendly materials, processes, and services at different degrees. Sweden is deeply committed to sustainable development and hosts one of the largest initiatives in materials science for sustainability, aimed at bridging fundamental science with societal and industrial needs. Many Swedish industries successfully incorporate recycled materials and circular approaches into their business models.

In Italy, the pharmaceutical industry is in the first place per quota of companies that undertake environmental sustainability actions and that have introduced innovations to reduce water and raw materials consumption per unit of product. Companies have adopted a comprehensive approach by considering the entire lifecycle of drugs while focusing increasingly on production efficiency and circularity. Italy also stands at the forefront of design in the world: beauty is the key to *Made in Italy* and sustainability.

The primary objective of this two-day event, hosted by the Stockholm university and co-organized with the Scientific Office of the Embassy of Italy in Stockholm, is to foster interaction and opportunities to strengthen the collaboration among Italian and Swedish teams working in this emergent and challenging field.

On behalf of the organizing committee,

Augusto Marcelli, *Embassy of Italy - Stockholm*
Erica Zeglio, *Stockholm University*

Maria Rosa Antognazza

Biography. I am a physicist by background, and I currently work as a researcher at the Italian Institute of Technology.
My main research interests concern the study and the development of biotechnology devices for optical modulation of living cells activity. I have a long-standing expertise in the characterization and implementation of bio-hybrid interfaces based on organic semiconductors and hybrid organic/inorganic devices, studied by optical, electronic, photo-electrochemical, ion imaging and electrophysiology techniques. I was awarded with the ERC-Starting Grant in 2019 (LINCE), and I coordinate several European and national collaborative projects. Currently, I lead a multidisciplinary group of about 10 people, comprising physicists, chemists, material scientists, engineers and biologists. I routinely serve as a reviewer for international Communication Materials (Nature Publishing Group) and of Frontiers in Biosensors and Biotechnology. I published >80 papers in high-impact journals, about 3K citations, 4 patents, >70 invited talks at international conferences and workshops. I consider communication of scientific results to the general public of upmost importance, and therefore I am often involved in outreach events. In 2022 Iwas mentioned among the *#unstoppable women*, the list of top-innovator women in Italy.

Organic semiconductors for regenerative medicine: optical modulation of the cell fate

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Keywords: cell fate, regenerative medicine, organic semiconductors, conjugated polymers, cardiomyocytes, endothelial cells, epithelial cells, stem cells, light, ROS

Use of light for selective and spatio-temporally resolved control of cell functions (photoceutics) is emerging as a valuable alternative to standard electrical and chemical methods. Here, we propose the use of smart materials, and in particular of organic semiconductors, as efficient and biocompatible optical transducers in the field of regenerative medicine.
Devices able to selectively and precisely modulate the fate of living cells, from adhesion to proliferation, from differentiation up to specific function, upon visible light will be presented. Examples of practical applications, recently reported by our group, include optical modulation of the activity of both excitable and non-excitable cells, the control of essential cellular switches like transient receptor potential channels and mechanosensitive channels, as well as effective

modulation of intracellular calcium signaling for precise control of cell metabolic processes. In more detail, we critically discuss the reliability and efficacy of our approach by focusing on a few, representative examples of possible applications:

i. non-toxic modulation of the cell redox balance, by functional interactionwith intracellular proteins[1];
ii. optical modulation of cell differentiation, migration and wound healing processes, by hybrid interfaces with mesenchymal stem cells and epithelial cells[2];
iii. optical modulation of cardiovascular cells, namely endothelial cells[3] and human induced pluripotent stem cells-derived cardiomyocytes (hPSC- CM).

Novel materials to optically modulate angiogenesis[4] and to optically induce an anti-arrhythmogenic effect will be presented[5]. Interestingly, these results may represent a breakthrough, noninvasive approach to face the cardiovascular risk, in particular post-ischemic disease and arrhythmias.

The above-mentioned study-cases represent, to the best of our knowledge, first reports on use of organic semiconductors for optical modulation of the cell fate, with disruptive perspectives in cell-based therapies and regenerative medicine.

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Luca Beverina

Biography. He graduated and got a PhD in Materials Science from the University of Milano/Bicocca. After a post Doc period at the Georgia Institute of Technology of Atlanta (GA, USA), he got a permanent position at the University of Milano Bicocca. Since 2019 He olds the position of Full Professor of Organic Chemistry at the University of Milano-Bicocca and Delegate of the Rector for the valorization of the Intellectual Property. His research focuses on design and synthesis of conjugated materials for (opto)electronics and biophotonics. In collaboration with leading international research groups, He developed molecules and polymers for OLEDs, OFETs, photovoltaic, electrochromic and sensor applications, amongst others. In the last 10 years, He dedicated increasing efforts to the application of green chemistry to the field of organic electronics, raising awareness on the need to improve sustainability alongside performances. He is also strongly involved in technological transfer in collaboration with several Companies. He has coauthored over 150 publications on peer reviewed journals and of over 20 patent applications.

Conjugated materials from and into interface rich, water based microheterogeneous environments. Introducing sustainability in organic electronics

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Keywords: conjugated materials, waste reduction, green chemistry, alternative raw materials, circular economy, printed electronics, biophotonics.

Conjugated materials are key components for organic devices. Established materials were originally designed and developed with performances in mind and with rigorous exclusion of water from the environment they were supposed to work in. This scenario is rapidly changing according to both the drive for the substitution of organic solvents with water in synthesis and processing and with the ever-increasing number of applications requiring a water/organics interface. The general rule for organic conjugated compounds is that solubility in water is very poor, unless complex and invasive functionalization is performed.
Formulation chemists developed efficient strategies to homogeneously disperse and stabilize hydrophobic derivatives in water by means of suitable amphiphilic molecules possessing a hydrophilic and a hydrophobic domain, called surfactants. They are capable of sizably reducing the interfacial energy associated with the presence of hydrophobic derivatives in an aqueous

environment. Above a certain concentration, most surfactants self-assemble in a variety of association colloids the most common of whom is the spherical micelle. At higher concentration, depending on the temperature and/or the ionic strength of the water solutions, more complex structures can also be observed.[1] The common characteristic of all such micro heterogeneous environments is the formation of lipophilic pockets within a polar environment where either additional surfactant or other lipophiles can be accommodated. In the early '80s synthetic chemists started realizing that association colloids are a simplified analogous of enzymes: reagents can be hosted and selectively localized in an environment with specific polarity, possibly leading to improved yield and selectivity.[2,3] The talk will focus on the opportunities that the formulation chemistry toolbox offers for the green synthesis and processing of established and new materials that could not be made otherwise.[4] Association colloids also offers the possibility to colocalize in a confined environment of controlled polarity, mixtures of different compounds that can be engaged in complex photophysical processes of interests for biological imaging and more.[5]

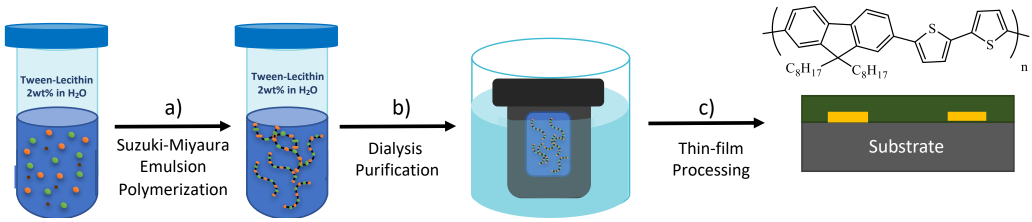

Figure 1: Micellar synthesis (a), purification via dialysis, and (c) direct deposition of a water dispersion of the p-type semiconducting polymer PF8T2.

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Fabio Biscarini

Biography. Prof. Fabio Biscarini is Full Professor of Chemistry at University of Modena and Reggio Emilia (UNIMORE) and Principal Investigator at the Istituto Italiano di Tecnologia-Center for Translational Neurosciences in Ferrara. He was Research Scientist then Research Director in CNR Bologna, 1996-2012, and professor of nanotechnology at Università di Bologna 2004-2013. He received the laurea in Industrial Chemistry cum Laude, Università di Bologna, 1986; the Ph.D. in Chemistry, University of Oregon (USA), 1993; was postdoc in CNR Bologna, 1994-1995. His research interests span across diverse aspects of physical chemistry and nanotechnology of molecular materials and soft matter. Current interests are organic bioelectronics in vitro and in vivo, implantable devices, organic neuroelectronics. He authored more than 285 publications to date and was co-inventor of 22 patents. He was coordinator and principal investigator in 40 EU and National projects. He was awarded the 2012 Premio Sapio Industria and the 2007 EU-Descartes Prize; he is Fellow of the Royal Society of Chemistry since 2004, Member of Academia Europaea since 2021, and Fellow of the Accademia Nazionale delle Scienze di Modena since 2018.

Organic Neuromorphic Devices for in-vitro Diagnostics and in vivo Neurophysiology

Fabio Biscarini[1,2*], Matteo Sensi[1], Marcello Berto[1], Alessandro Paradisi[1], Pamela Manco Urbina[1], Katherina Solodka[1], Anna De Salvo[2], Deniz Saygin[2], Alice Lunghi[2], Sonia Guzzo[2], Federico Rondelli[2], Matteo Genitoni[2], Michele Di Lauro[2], Mauro Murgia[2,3], Pierpaolo Greco[2,4], Michele Zoli[5], Michele Bianchi[1,2], Carlo Augusto Bortolotti[1], Luciano Fadiga[2,4].
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Keywords: organic bioelectronics, organic transistors, neuromorphic devices; artificial synapses; immunosensors; implantable neuroelectronics.

Organic bioelectronics has proven an outstanding platform for (bio)sensors and transducers of chemical and electrophysiological signals in vitro and in living systems. Our aim is to develop a sustainable platform for the point of care and in-field deployed applications. We explored and devised a variety of organic electronics immunosensors based on the functionalized gate of a transistor as element for biorecognition and active organic (semi)conductive materials and nanostructured thin films [1, 2].

We also pioneered organic neuromorphic sensors (artificial synapses) that, driven in frequency and intensity, respond as selective biosensors of some relevant biomolecules, without the requirement of a specific recognition moieties integrated in the device [3]. Some of the most recent architectures both for in vitro diagnostics and for in vivo recording of and stimulation with electrical and chemical signals will be presented [4, 5]. Some of their relevant features, like short and long term plasticity, learning, recognition/classification [6], and autonomous actuation of drug delivery based on the neurophysiological input signal will be discussed.

These topics were also the focus of collaborative EU and IT/SE projects participated by UNIMORE, IIT and the Laboratory of Organic Electronics at University of Linköping in Norrköping from 2012 (EU iONE-FP7, Miur IT/SE Strategic Project Poincaré, EU MSCA-ITN Borges) and EU proposals in preparation.

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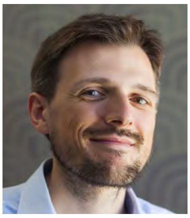

Mario Caironi

Biography. Mario Caironi is a Senior Scientist at the Center for Nano Science and Technology (Milan, Italy) of the Istituto Italiano di Tecnologia (IIT). His main research interests focus on large-area organic and hybrid printed opto-electronics, on edible and sustainable electronics, and organic bioelectronics sensors. He obtained his Ph.D. in Information Technology with honours at Politecnico di Milano (Milan, Italy). In 2007 he joined the group of Prof. Sirringhaus at the Cavendish Lab. (Cambridge, UK) as a post-doc, working for 3 years on high resolution printing of downscaled organic transistors and circuits, and on charge transport in high mobility polymers. In 2010 he was appointed as Team Leader at IIT. In 2014 he entered the tenure track at the same institution, obtaining tenure in 2019. He is a 2014 ERC Starting grantee and a 2019 ERC Consolidator grantee. He is co-founder of two startups in printed organic electronics. He is serving as editor for IEEE Transaction on Electron Devices and for IEEE Journal on Flexible Electronics.

Recent Progress in Edible Electronics and Printed Organic Biosensors

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Keywords: ingestible electronics, sustainable electronics, printed electronics, printed biosensors

In this contribution I will report on our recent progress in two main fields: edible electronic devices towards future edible electronic systems for healthcare and food monitoring applications, and printed biosensors, focusing on the recording of action potentials in electrogenic cell cultures.
Edible electronics[1] envisions a technology that is safe for ingestion, environmentally friendly, and cost-effective. It aims at realizing electronic devices that are degraded within the body after performing their function, either digested or even metabolized, thus removing any retention hazard. Edible electronics could potentially target a significant number of biomedical applications, such as remote healthcare monitoring, and food monitoring applications as well (Figure 1). Here I will first give an introduction to this emerging field and propose long-term opportunities in terms of environmentally friendly smart technologies, remote healthcare monitoring, along with the challenges ahead. Then, I will report on our recent progress in the development

of edible circuitry and components, towards future integrated edible electronic systems.

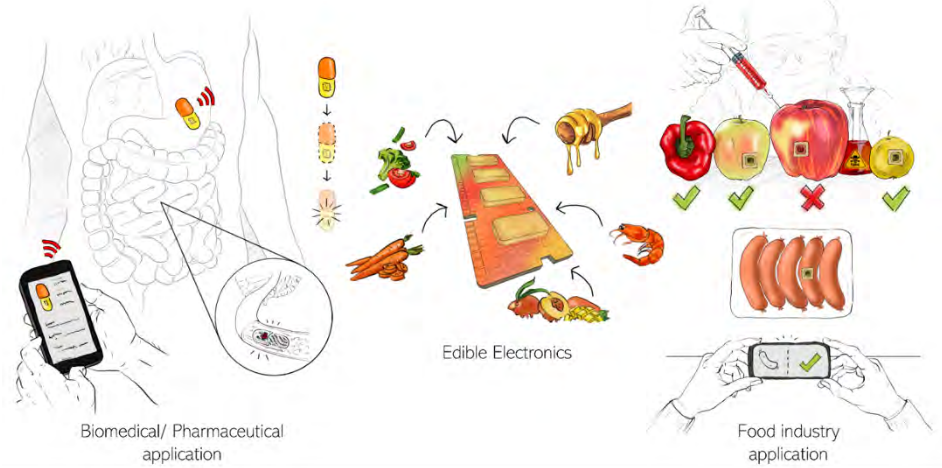

Figure 1: Long-term vision for application of edible electronic systems in the biomedical and food industry.

In the second part of my talk, I will touch upon minimally invasive tools for recording of intracellular action potentials in electrogenic cells, which are in high demand. Most of present electrical probing tools are either invasive or require complex manufacturing processes. With the aim of enabling a cost-effective, non-invasive probing platform based on devices that can be easily fabricated and processed from solution with large-area printing techniques, we propose planar Electrolyte Gated Field-Effect Transistors based on solution-processed carbon based semiconductors.[2] Remarkably, despite the planar geometry of the device, we could demonstrate the spontaneous recording of "intracellular-like" action potentials of human induced pluripotent stem cells derived cardiomyocytes (Figure 2).

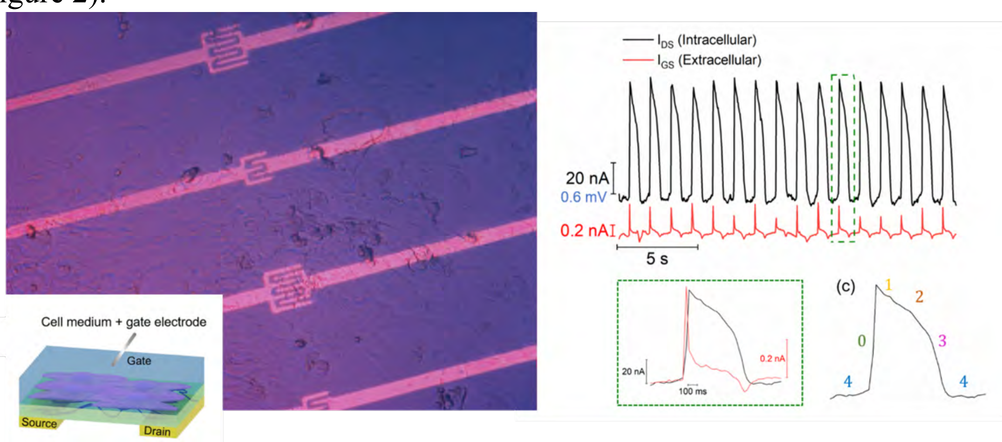

Figure 2: Printed biosensors based on electrolyte-gated carbon-nanotubes allowing the the direct recording of action potentials of a cardiomyocytes culture.

The simplicity of the device combined with the high signal to noise ratio opens up new opportunities for low-cost, reliable, and flexible biosensors and arrays for high quality parallel recording of cellular action potentials.

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Michele Di Lauro

Biography. Michele Di Lauro is a researcher at the Center for Translational Neurophysiology of Speech and Communication of the Italian Institute of Technology, in the "Organic Neuroelectronics" research line. During his PhD course in Molecular and Regenerative Medicine (2014-2016) and in subsequent post-docs at both UNIMORE and IIT, he specialized in the fabrication, the characterization and the modeling of organic electronic devices at the interface with biological environment. Currently, his research activity is focused on the clinical validation of implantable organic electronic devices for lesion border mapping in infiltrating tumors of the central nervous system in humans, as well as on the development of innovative theranostic approaches to neuropathological conditions, arising from both neurodegenerative diseases and post-traumatic or post-surgical injuries. To this end, he investigates fundamental aspects of charge transport in organic (semi-)conductive materials at the interface with complex electrolytes and living matter (in vitro and in vivo), with a particular focus on frequency dependent phenomena. The latter allowed him to contribute seminal advancements in the newly defined field of "Organic Neuromorphic Bio-electronics". He has authored more than 40 publications in international peer-reviewed scientific journals (Scopus H-index:16) and co-authored the headword "Organic Electronics" in the main Italian Encyclopedia (Treccani, est. 1929).

Organic neuromorphic devices as building blocks for neuroelectronics

Michele Di Lauro[1*], Anna De Salvo[1], Federico Rondelli[1,2], Mauro Murgia[1,3], Pierpaolo Greco[2], Luciano Fadiga[1,2] and Fabio Biscarini[1,4]

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Keywords: organic neuromorphic devices, organic neuroelectronics, organic bioelectronics, neuromorphic response, electrolyte-gated organic transistors

Organic electronic neuromorphic components and devices operated in electrolyte are being investigated as powerful tools for bio-sensing, since their response is quantitatively determined by the composition of operational electrolyte,[1] or as signal processing units, thanks to their selective response to frequency which enables low-power computation at the hardware level.[2,3]

Given the inherent match between the timescales, the chemical identity of the charge carriers and the signal processing logic paradigms in the brain and in organic neuromorphic devices, the latter are - ideally - the natural choice when tackling the convoluted task of efficiently interfacing neural tissue, establishing bidirectional exchange of information. Nonetheless, the implementation of neuromorphic devices and concepts in neuroelectronic interfaces designed specifically for clinical applications comes with a number of practical and conceptual hurdles which should be addressed, from both sides of the biotic/abiotic interface.

Scope of this presentation is to discuss some of these critical issues, which have so far impaired translation of neuromorphism in clinical scenarios, and to present strategies for overcoming them, with a focus on connection schemes and characterization strategies as well as on device geometry and material processing, hoping to trace a useful *vademecum* for Organic Neuromorphic Neuroelectronics development.

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Gianluca Maria Farinola

Biography. He is Professor of Organic Chemistry at the University of Bari Aldo Moro, Italy. From 2019 he is pro-Rector for Research and Innovation. He is the President of Società Chimica Italiana (2023-2025).
He has been visiting researcher at the Universities of Muenster, Strasbourg (Institut de Science et d'Ingégnerie Supra-moléculaire – ISIS), Angers, and he has been appointed Adjunct Professor at the Department of Biomedical Engineering at Tufts University (Medford, Boston).
He is recipient of the Ciamician Medal of the Italian Chemical Society and of the "Innovation in Organic Synthesis Award" of the Interuniversitary Consortium CINMPIS. He is Chemistry Europe Fellow and member of the Istituto Lombardo di Scienze e Lettere.
Research of Gianluca Farinola focuses on sustainable synthetic methods to produce functional organic and hybrid materials for emerging technologies in organic photonics, optoelectronics and biomedicine. More recently his studies have been also focused on biological polymers (melanin, biosilica, fibroin, lignin) and living materials, including photosynthetic microorganisms (algae and bacteria).

Living materials for optoelectronics from biopolymers and photosynthetic microorganisms

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Keywords: Living materials, biopolymers, sustainable materials, bio-optoelectronics, photosynthetic microorganisms

Microalgae and photosynthetic bacteria produce a wide variety of functional structures, optimized in billions of years of evolution, for interaction with light and photoconversion. Incorporating these structures or entire living cells as active materials in optoelectronic devices has been achieved by using biological or biomimetic polymers as interfaces with electrodes. Our approach opens new ways towards designing sustainable materials for optoelectronics [1].
The following examples will be presented in the lecture:
i) Photosynthetic bacterial enzymes functionalized with light absorbing molecules [2] and used as photoconverters in optoelectronic devices [3].
ii) Nanostructures obtained by *in vitro* or *in vivo* chemical modification of

biosilica shells of microalgae (diatoms) with intriguing photonic properties [4].
iii) Intact photosynthetic bacteria or microalgae cells used as living materials in photoelectrochemical cells for solar energy conversion [5].
The lecture will discuss the logic of designing and synthesizing the biohybrid micro/nano assemblies and will highlight the challenges raised by the controlled functionalization and integration in devices.
New sustainable materials and devices for optoelectronics can therefore be created, based on biotechnological production of photosynthetic microorganisms and biopolymers.

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Beatrice Fraboni

Biography. BF is Full Professor of Physics at the Department of Physics and Astronomy of the University of Bologna, where she coordinates the "Semiconductor Physics Group" (https://site.unibo.it/semiconductor-physics/en).
Her experimental research activity covers both organic and inorganic semiconducting materials, with particular focus onto their optoelectronic and charge transport properties. Nanostructured materials, interfaces and defective states are investigated, targeting the development of advanced materials for (bio)electronic sensing. In particular, the research targets printable flexible electronic devices for radiation detection and for organic bioelectronics, in terms of advanced functional materials and of biosensors for wearable applications, including novel sensor functions integrated in “smart textiles” textile materials. She presently serves as Editor in Chief of the International journal “European Physics Journal -plus EPJP” (Springer Editor) and is the President of the Istituto di Studi Superiore (https://www.unibo.it/en/university/campuses-and-structures/institute-for-higher-studies) of the University of Bologna, where she served as Rector’s Delegate for the International Relations of the University of Bologna (2015-2020). She has coordinated European, Italian and regional projects and has chaired various International Conferences on Material Science and (Bio)sensors. Author of over 200 scientific publications in international peer-reviewed journals, over 60 invited talks and 17 patents, she is active in technology transfer.

Fully-organic flexible detector for real-time dose monitoring during radio/proton therapy

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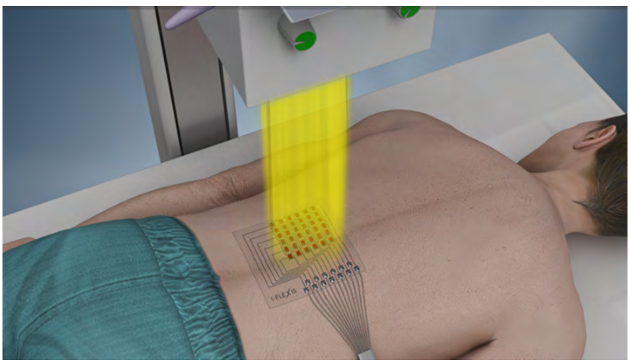
Keywords: organic semiconductors, thin film devices, medical dosimeter

The development of detectors for high energy photons, protons and heavy particles is a long-lasting research topic not only for fundamental applications but also, more recently, for medical applications in radio and hadron therapy of cancer and for space crew personal dosimeters. In this field, high energy photons (X and gamma rays) and ion beams, mostly proton beams, are used for the controlled treatment of cancer by focusing them onto small volumes to deliver energy to the tumor. The effectiveness and safety of the treatment is enhanced by tuning the beam both in intensity and in position to irradiate the tumor in a controlled way, preserving the surrounding healthy tissues. For this reason, there is an increasing demand for sensors able to provide, ideally in-situ and in real-time, an accurate recording and mapping of the dose delivered during a treatment plan. The development of novel high performing, thin and flexible sensors for the detection of ionizing radiation in real-time at affordable costs is rapidly increasing, as the technology currently available still fails to address the requirements of large-area, conformability and portability, lightweight and low power operation.

Organic small molecules and polymers are promising active layers for advanced dosimetry purposes, as their mechanical features allow the development of devices able to adapt to complex contoured surfaces, with outstanding portability (low power operation) and lightweight. Organic semiconductors can be processed from solution and deposited at low temperature (<150 °C), leading to the possibility to realize 2D matrices of pixels onto flexible and large-area substrates (see figure below). They also provide the unique possibility to develop human-tissue-equivalent detectors, thanks to their density and composition, which makes them ideal candidates for medical dosimetry applications. Their low average atomic number and density also grants a low absorption of the incoming radiation, making them extremely radiation-tolerant. The physical process of radiation detection for organic thin- film based detectors will be discussed in two different configurations: 1) the direct one, based on a simple planar device with an organic thin film as active conversion layer, and 2) the indirect one, based on a polysiloxane-based scintillating layer effectively coupled to an organic phototransistor (OPT).



We report on their performance under exposure to intense photons and MeV protons radiation fields and will discuss how to detect and exploit the energy absorbed both by the organic semiconducting layer and by the plastic substrate, allowing to extrapolate information on the irradiation history of the detector. A new kinetic model has been developed to describe the detector response mechanism, able to precisely reproduce the dynamic response of the device under photon/proton irradiation and to provide further insight into the physical processes controlling its response.

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Guglielmo Lanzani

Guglielmo Lanzani is a physicist. Full professor at Politecnico di Milano, he has served from 2010 to 2023 as Director of the Center for Nano Science and Technology at Italian Institute of Technology, where he is senior researcher. He studies photoresponsive materials able to induce light sensitivity and signaling in biological systems. The ultimate goal is to realize photo-driven human-machine interfaces for application in regenerative medicine, prosthetics and hybrid robotics. He has recently developed, in collaboration with neuroscientist and medical doctors, a new retina prosthesis that exploit semiconducting polymer nanoparticles for rescuing vision in photodetector-degraded retinas. He is funding partner in three start-ups (NOVAVIDO, RIBES TECH and SAMS Technology).

Organic phototransducers for abiotic/biotic coupling

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Keywords: biophotonics, cell optostimulation.

This presentation provides an overview of our current research progress in the field of organic phototransducers development. These phototransducers are designed to absorb light and convert it into electricity. We apply these phototransducers to cells, and when we expose these cells to light, the absorbed light is converted into electricity, enabling us to stimulate the cells. Our phototransducers are based on nanoparticles or intra-membrane molecular probes. Investigating the intricacies of their coupling mechanism is a fundamental aspect of our research objectives. We anticipate various applications in healthcare, life-enhancement, and cyborg technologies. A notable example is the potential restoration of vision in individuals with visual impairments.

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Eleonora Macchia

Biography Dr. Eleonora Macchia (female) is tenure track Assistant Professor at Department of Pharmacy at University of Bari and Head of Research at Åbo Akademi University. She is ERC Starting Grant 2021 grantee, being PI of the project NoOne (GA number 101040383). She has been Senior Researcher, as PI of the project ProSiT, funded by Academy of Finland Research Council (GA#332106). Since March 2019, she has been project researcher at Åbo Akademi University, in the framework of the H2020 project SiMBiT (GA#824946). Previously, she has been Postdoc at University of Bari. She received her PhD in Chemical Sciences summa cum laude in 2018 from the University of Bari and her Master's degree in Physics 110/110 cum laude in 2014 from the same institution. She was awarded with 8 scientific awards and she was selected as Top 10 candidate of the XVII Edition of the award "L'Oréal Italia Per le Donne e la Scienza". At the age of 32, she has already published 54 publications in major international journals since 2013, with a total of 1,097 citations, yielding an h-index of 19. She is co-inventor of two patents. She is also strongly committed to the role of model for younger women scientists.

Single-molecule bioelectronic sensor: improving reliability with machine learning approaches

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Keywords: machine learning, single molecule detection, bioelectronic devices

Digitizing biomarkers analysis by quantifying them at the single-molecule level is the new frontier for advancing the science of precision health. The enhancement of the technical capabilities of bioelectronics systems, by giving clinicians the possibility to rely on biomarkers quantifications down to the single-molecule, holds the potential to revolutionize the way healthcare is provided. Such an analytical tool will indeed enable clinicians to associate a biomarker tiniest increase to the progression of a disease, particularly at its early stage.[1] Eventually, physicians will be able to identify the very moment in which the illness state begins. Such an occurrence will enormously enhance their ability to cure diseases by supporting better prognosis and permitting the application of precise treatment methods. The single molecule bio-electronic smart system array for clinical testing - SiMBiT - technology has been developed within the blooming field of precision medicine, leveraging on the single molecule with large transistor (SiMoT)[2] lab-based technology that can perform single-molecule detection of both proteins and DNA bio-markers.[3,4] Specifically, the SiMBiT technology has lately developed the SiMoT lab-based device into a cost-effective portable prototype multiplexing array that integrates, with a modular approach, standard components and interfaces with novel materials and exhibits enhanced sensing capabilities. The SiMBiT prototype has proven its potency in early detection of pancreatic cancer, being capable to discriminate among low-grade and high-grade mucinous cyst's lesions in peripheral biofluids, such as plasma samples. In this perspective, machine learning approaches play a pivotal role in developing classifiers for a fast, reliable multiparametric biosensors output.[5] Supervised model based on multivariate data processing has been undertaken to enable multiplexing, *i.e.* the simultaneous quantification of three biomarkers, namely MUC1 and CD55 proteins and KRAS DNA mutated sequence, in plasma and cysts' fluid samples. The main technological aspect of the SiMBiT device, with particular emphasis on the potency of machine-learning approaches, will be discussed.

Figure 1: SiMBiT bioelectronic platform

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Luisa Torsi

Biography. She is a professor of chemistry at the University of Bari and president of the Regional Center on Single-Molecule Digital Assay. She received her laurea degree in Physics and the PhD in Chemistry from UNIBA and was post-doc at Bell Labs in USA.
In 2010 Torsi was awarded the H.E. Merck prize. In 2019, she received the Distinguished Women Award from IUPAC. She was also the only women president of the European Material Research Society. Luisa Torsi is the winner of the Wilhelm Exner Medal 2021, a prize awarded since 1921 by the Austrian Industrial Association and the Premio del Presidente della Repubblica dell'Accademia dei Lincei. Afterwards she has also been elected member of this prestigious Accademy.
Torsi has authored *ca.* 230 papers, published also in Science and Nature journals. Her works collected almost 16.300 Google Scholar citations resulting in an h-index of 63. Gathered research funding for over 40 M€, comprises several projects, mostly coordinated by her. Torsi is committed to the role-modeling for women scientists. In a campaign by Fondazione Bracco, she was featured in TOPOLINO (Italian series of Disney comics), as "Louise Torduck", a successful female scientist of the Calisota valley.

Single-molecule bioassays for one-healthcare at the point of care

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Keywords: point-of-care-testing (POCT), single-molecule, one-health, preventing-healthcare, Single-Molecule-with-a-large-Transistor (SiMoT), lateral-flow-strip-test, Clustered-Regularly-Interspaced-Short-Palindromic-Repeats/Cas(CRISPR/Cas)

Conducting accurate point-of-care testing (POCT) using user-friendly, cost-efficient, and highly reliable in-vitro diagnostic devices is essential for effectively screening asymptomatic individuals across various domains, including humans, animals, and plants. The need for convenient surveillance underscores the significance of readily deployable diagnostic tools that maintain exceptional accuracy and portability, meeting the criteria set forth by the World Health Organization for POCT systems.
Currently, the market lacks a device that fully satisfies these requirements. However, two promising technologies have emerged at readiness level 5: the Clustered Regularly Interspaced Short Palindromic Repeats/CRISPR lateral

flow strip tests[1-2] and the Single Molecule with a large Transistor/SiMoT bioelectronic handheld devices.[3-5] Both these innovations embody essential characteristics specified by the World Health Organization for POCT, ensuring minimal occurrences of false-positive and false-negative errors, each ranging from 1% to 5%. This accuracy translates to a diagnostic selectivity and sensitivity exceeding 95% to 99%. Additionally, the limit of detection for these technologies is impressively low, enabling the identification of even minute markers.

The CRISPR-strip functions as a molecular assay, capable of detecting as few as three copies of DNA/RNA markers within blood samples. Meanwhile, the SiMoT immunometric and molecular test exhibits the capacity to identify a single oligonucleotide, protein marker, or pathogens within just 0.1 mL of blood, saliva, or even olive sap.

These advancements hold the potential to revolutionize systematic and dependable surveillance of asymptomatic individuals prior to the onset of illnesses. By enabling timely diagnosis and rapid prognosis, these technologies pave the way for a proactive healthcare framework. Ultimately, this approach establishes an ecosystem that fosters effective treatments for diverse organisms, thereby promoting widespread well-being and health at an efficient cost.

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Maria Asplund

Biography. Maria Asplund is an expert in bioelectronics including flexible microtechnology, tissue-device interaction and electronic biomaterials. She is appointed as professor in Bioelectronics at Chalmers University of Technology. After completing her PhD at the Royal Institute of Technology (Stockholm, 2009) she led her own research group at the University of Freiburg, Germany (2011-22). Her work has resulted in new technologies which contributes to smaller, more energy efficient and durable bioelectronics in the future. She currently holds an ERC proof of concept grant, is a Visiting Professor at Luleå University of Technology (2019-23) and an editorial board member of Bioelectronic Medicine. Maria Asplund is also the scientific secretary for the Swedish Society for Medical Engineering.

Why future bioelectronic medicine requires unconventional electrode materials

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Keywords: laser induced graphene, conducting polymers, bioelectronics, neurotechnology, microsystems engineering, wound healing

Bioelectronic medicine use electrical signals, either recorded from or injected into tissue, to reach a therapeutic effect. To date, research almost exclusively focused on its applications in the nervous system, to large extent overlooking the potential of bioelectronic medicine in other types of tissue. While excitable cells respond to rapid changes in potential, continuous electric fields and direct current activate different and more subtle bioelectrical mechanisms. This possibility deserves more attention. For instance, electric fields can influence how cells migrate and grow, making electrical field stimulation highly relevant for guiding regenerative processes [1-3].
Key to these applications is to identify electrode materials that make it possible

to reliably administer current directly to cells and tissues, without worrying about corrosion and the reactive by-products of stimulation. For direct current, even high-cost materials such as noble metals (platinum and gold) have limitations in terms of charge injection, and their electrochemistry is not well-matched to the nature of the biological signals they should mimic [1]. Carbon and polymer based conductors offer completely new opportunities in this field [4,5]. They can be tailored to fit requirements and, in many cases, actually outperform the typical metals. In addition, they offer an opportunity to make bioelectronic devices without relying on rare and expensive elements. This route to make devices based on sustainable materials opens new possibilities for the field, in particular to enable disposable systems for non-invasive applications and in vitro assays.

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Magnus Berggren

Biography. Magnus Berggren received his MSc in Physics and PhD in Applied Physics in 1991 and 1996, respectively, from Linköping University in Sweden. After that, he joined Bell Laboratories, USA, for postdoctoral studies focusing on the development of organic lasers. In 1997, he co-founded Thin Film Electronics AB and for one and a half years he served the company as its managing director with the prime mission of developing printed electronic memories. Then, he returned to Linköping University and also joined Acreo (today RISE) to establish the research in printed and paper electronics, in part supported by the paper- and packaging industry. Since 2002, he holds the professorship in, and is the director of the Laboratory of, Organic Electronics, Linköping University, today including about 140 people organized in 12 different research groups. Magnus Berggren is one of the pioneers behind Paper Electronics, Organic Bioelectronics and Electronic Plants and in 2012 and 2018 he became an elected member of the Royal Swedish Academy of Sciences and the Royal Swedish Academy of Engineering Sciences (IVA), respectively. In 2014 he received the Marcus Wallenberg Price and in 2017 he received the IVA gold medal. He has co-founded more than 10 companies in the areas of Organic Energy Materials, Internet of Things and Biotechnology. Since January 2022, Magnus is the director for the Wallenberg Initiative Material Science for Sustainability, which is a 300 million USD national research program operating from 2022 through 2033 composed of research projects, strategic recruitments, guest professorships and collaboration initiatives with industry.

Substrate-free Organic Bioelectronics Integrated with Living Cells and Tissues

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Organic Electronics provide a wide array of signal translation properties and features making the communication between biology and technology going far beyond what is possible with traditional metal electrodes and inorganic electronics. In addition, organic electronic materials also provide necessary biocompatibility and biostability characteristics, represented by softness, flexibility, and chemical tunability. However, high-performing signal transfer across the biology-technology gap also relies on close integration, proximity, and selective connection to targeted biological components, which is problematic when (organic) electronics is manufactured and defined on substrates and carriers.

Here, the concept of in vivo-manufacturing of substrate-free organic bioelectronics is reported based on a set of recently synthesized and explored thiophene-based trimers. Those trimers have been equipped with proper side groups aiding integration with walls, clusters, and larger systems of cells possible in a tight and selective manner. Electrodes and electroactive structures are then derived using available metabolic components, of the biological system, to power the polymerization. We can control aggregation, in-biding to cells and polymerization in a highly balanced manner, which together provides us with a protocol to achieve complex structures using cells and systems thereof as the template to generate electrodes and electronic structures. The resulting substrate-free bioelectronics are highly conductive and offer novel routes for bio-integration. We will report substrate-free organic bioelectronics applied to various cell lines and animal models.

Peter Andersson Ersman

Biography. Peter Andersson Ersman works with various projects within the fields of printed, bio- and organic electronics. The research education at Linköping University initiated the development of matrix addressed electrochromic displays; an education that after the dissertation in Organic Electronics resulted in an employment at RISE Research Institutes of Sweden (formerly Acreo) as a research scientist and project manager. The work related to active and passive matrix addressed electrochromic displays, that now successfully have been manufactured by printing tools, have resulted in several patent applications and journal publications throughout the years. He is also responsible for R&D activities related to printed segment-based electrochromic displays and printed circuits based on organic electrochemical transistors that are being developed at RISE. The activities are therefore ranging from improvements of transistor and display architectures to the development of manufacturing processes on a variety of substrates, as well as commercialization of the printed electrochromic display technology together with the company Ynvisible. During recent years, activities aiming at monolithic integration of, for example, printed circuits, electrochromic displays and sensors, preferably on sustainable and flexible substrates, have been the main focus.

All-printed organic electronic components and systems for sustainable (bio)electronic applications on flexible substrates

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Keywords: screen printing, PEDOT:PSS, OECT, electrochromic displays, printed electronics

RISE Research Institutes of Sweden develops a broad range of printed electronic components and systems on flexible substrates, most often by solely using screen printing for the deposition of the materials. Electrochromic displays, organic electrochemical transistors and sensors are all examples of components in which improved performance and high manufacturing yield recently have been demonstrated, thereby allowing for further utilization within flexible electronics upon system integration. The presentation provides an overview of this development: device architectures, materials, printing processes, system integration, device characterization and application areas.

Additionally, the ongoing digitalization of the modern world necessitates manufacturing of electronic IoT devices in a sustainable manner. The constant demand for sensing, monitoring and connecting numerous devices in our daily lives is putting a strain on our resources and creating challenges in their disposal. Therefore, our most recent efforts on developing sustainable electronics will also be demonstrated.

Figure 1. Left: Screen printed passive matrix addressed electrochromic display with 17 grayscale levels.[1] Middle: all-organic electrochromic displays screen printed on transparent nanocellulose-based substrates.[2] Screen printed OECT-based shift register.[3]

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Simone Fabiano

Biography. Simone Fabiano is an associate professor and docent in Applied Physics at Linköping University, Sweden. He obtained his PhD in Chemistry from the University of Palermo in 2012. During his doctoral studies, he was a visiting scholar at the Zernike Institute for Advanced Materials of the University of Groningen, The Netherlands. He then held postdoctoral positions at both Linköping University (2012-2015) and Northwestern University (2016-2017) before returning to Linköping University to establish his research group. In 2020, he founded n-Ink AB, a spinout company that focuses on developing n-type organic conductive inks, where he serves as the Chief Scientific Officer. His group at Linköping University primarily focuses on developing organic dopant-free conductors and mixed ionic-electronic conductors for printed electronics and neuromorphic hardware applications. He has received several awards, including the Swedish Research Council Starting Grant in 2017 and Consolidator Grant in 2023. He is also a Wallenberg Academy Fellow.

Organic electrochemical neurons with ion-mediated spiking

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Keywords: bioelectronics, organic mixed conductors, artificial neurons

Biointegrated neuromorphic hardware holds promise for new protocols to record and regulate signaling in biological systems. Traditional neuromorphic systems based on silicon have limited bio-integration potential due to circuit complexity, poor biocompatibility, and low energy efficiency. Organic mixed ionic-electronic conductors (OMIECs) offer a potential solution to these limitations. Because of their structural kinship with biomolecules and coupled ionic-electronic transport functionalities, OMIECs are an excellent choice for bridging electronics and biology, enabling energy-efficient signal transduction. In this presentation, I will explore the use of OMIECs to develop organic electrochemical neurons that possess ion-modulated spiking capabilities. I will discuss their ease of integration with biological nerves and demonstrate neurosynaptic circuits that can modulate spiking through neurotransmitters, amino acids, and ions[1-3]. These soft, flexible organic electrochemical neurons and synapses operate at low energy and respond to multiple stimuli, signaling a new era for organic bioelectronics.

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Alexander Giovannitti

Biography. Alexander Giovannitti received a Diploma in Chemistry from the Karlsruhe Institute of Technology (KIT), Germany, and an MRes and Ph.D. in Polymer Chemistry from the Center for Plastic Electronics, Department of Chemistry and Physics at Imperial College London, United Kingdom. As an EPSRC Doctoral Prize Fellow, he joined the group of Prof. Jenny Nelson at Imperial College, Department of Physics, United Kingdom. In 2019, Alex moved to Stanford University as a TomKat Postdoctoral Fellow, Department of Materials Science and Engineering, USA. Since April 2023, Alex is an Assistant Professor in the Department of Chemistry and Chemical Engineering at Chalmers University of Technology.

Next-generation polymeric organic semiconductors for electrochemical transistors in aqueous electrolytes

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Keywords: Redox-active polymers, Mixed conducting polymers, electrochemical transistors, structure-property relationships

Over the last decade, significant progress has been made in developing efficient mixed-organic-ionic-electronic conductors (OMIECs) for electrochemical transistors. Improvements in device performance for both transconductance and operational stability paved the way for applications of electrochemical transistors for health monitoring, neuromorphic computing, or electrochemical sensors. While the tuning of the energy levels (via backbone engineering) and the local environment of the polymers (via side-chain engineering) is reported to be a successful strategy for improving the electronic and ionic charge transport properties, little is known about how the short- and long-range order of polymers impacts the device performance.

In my talk, I will discuss the importance of microstructure and dynamic microstructural rearrangements of OMIECs which greatly influence the electronic charge transport properties in electrochemical transistors [1]. By combining electrochemical and spectroelectrochemical measurements alongside electrochemical X-ray diffraction measurements, we observe that holes and anions are placed in ordered aggregates and crystallites at relatively low charge carrier densities (< 2x10^20 cm^-3) for selected OMIECs, explaining the large increase in transconductance at low operational voltages. Moreover, we find that the electrochemical charging of p-type polymeric OMIECs induces structural order along the polymer backbones.

We interpret this structural ordering as the key factor for achieving high transconductance since percolating networks can form more easily when polymer chains are planarizing. Surprisingly, these dynamic microstructural rearrangements are highly reversible, however only when high charge carrier densities are avoided at which bipolarons are formed. Based on these findings, I will discuss chemical design strategies for next-generation OMIECs with improved transconductance and operation stability in electrochemical transistors.

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Mahiar Max Hamedi

Biography. Max Hamedi is a professor at the Royal Institute of Technology KTH.
His current research involves fundamental studies and development of new materials based on polymers and electronic nanomaterials, creating emergent functions that arise from macromolecular self-assembly, bridging the gap between synthetic materials, electronics, and biology.
He is currently working with energy storage, macromolecular intelligent systems, and technologies for democratization of molecular diagnostic for global health.
His research has been highlighted by many news organizations including BBC, Science, Nature, CNN, and MIT tech. review, and Wired. He is also the co-founder of several companies and managing director of a private investment fund.

Superstrong Electronic Hydrogel Actuators (ECO)

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Keywords: Hydrogels, Actuators, Intelligent systems

Intelligent systems combine sensing, actuation, and computation to achieve complex tasks and functions. Soft electrically controlled multifunctional materials, especially hydrogels, are the most promising materials for such systems as they are as adaptable as biological systems yet compatible with advanced systems through electronics.
We describe an electroactive hydrogel fabricated from cellulose nanofibrils from trees, and conductive nanomaterials, like CNTs or 2D MXenes. These nanoparticles self-assemble into an anisotropic composite network with an open mesoporous structure that can hold lots of water and be highly permeable to substances in their surroundings. The anisotropy of the network allows high expansion in one direction while maintaining very high strength and high electric conductivity in the other.
The electrochemical charge/discharge of the conductors in the hydrogels controls the internal salt concentration and consequently their osmotic swelling. This allows direct electrically controlled actuation where around 700 water

This allows direct electrically controlled actuation where around 700 water molecules expand/contract the structure for each ion/electron pair inserted/de-inserted at only ±1 volt, resulting in up to 300% electroosmotic expansion, with very high pressures reaching 1 MPa.

This mode of electronic actuation has not been shown before. We call these electroosmotic (ECO) actuators [1]. Our ECO hydrogel actuators have emergent properties not present in any previously known soft material. ECOs allow for monolithic integration of sensors and many other functions into the same composite, rendering a new form of smart soft material not achievable with other materials systems.

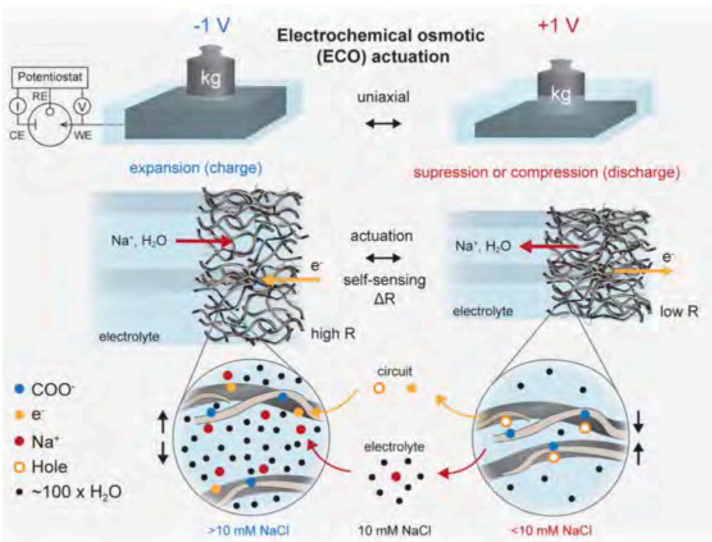

Figure 1. Schematic principle of ECO hydrogel actuators

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Christian Müller

Biography. Christian Müller is professor in Polymer Science at Chalmers University of Technology in Göteborg, Sweden. His research interests include the use of organic semiconductors and polymer blends in the fields of wearable electronics and energy technology. He received an ERC Consolidator Grant in 2022 and is a Wallenberg Scholar.

Interplay of Electrical and Mechanical Properties of Doped Conjugated Polymers

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Keywords: chemical and electrochemical doping, stiffness, composites, fibers

Chemical and electrochemical doping are widely used to modulate the electrical properties of conjugated polymers. Doping of thin films facilitates fundamental spectroscopic studies and, ultimately, is important for the operation of devices from transistors to solar cells. However, some applications such as thermoelectrics and wearable electronics require bulk materials, which complicates doping processes and mass transport, limiting the performance of devices. This talk will explore some of the fundamentals of doping of both thin films and bulk materials. The impact of doping on the electrical as well as mechanical properties will be discussed, and it is shown how doping can be used to tune both the conductivity and stiffness of conjugated polymers. Finally, strategies are explored that permit to decouple the effect of doping on the electrical and mechanical properties, which can be used to prepare a variety conducting bulk materials, from stiff composites and foams to hydrogels and stretchable fibers.

Onur Parlak

Biography. Onur Parlak is an Assistant Professor at Karolinska Institute in the Department of Medicine, Dermatology and Venereology Division. Dr. Parlak received his PhD degree in Bioelectronics from Linköping University in 2015. He then joined Stanford University for postdoctoral research. After spending three years at Stanford, he turned back to Sweden and joined the Karolinska Institute to translate his engineering skills into medical settings with the support of Knut and Allice Wallenberg Foundation (KAW) starting grant in 2019. He has been recently awarded by Karolinska Institute and acting as a research group leader as a part of the Karolinska investment program to recruit and support leading young researchers with particularly outstanding scientific merits and future potential. He has recently awarded by prestigious European Innovation Council and Swedish Research Foundation starting grants in Medicine and Health. His research group at Karolinska and Centre for Molecular Medicine specializes in epidermal sensors and personalized diagnostics.

Epidermal Sensors for Medical Diagnostics

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Keywords: diagnostics, medical sensors, epidermal bioelectronics

Epidermal bioelectronic devices show great promise in healthcare due to their ability to provide longitudinal monitoring as well as on-demand delivery to maintain optimal health status and evaluate patients' physical conditions.[1] Epidermal biosensors are at the center of this effort and offer a vast potential to revolutionize conventional diagnostics that uses traditional laboratory tests-based evaluations, usually called 'clinical labs,' that are slow and mainly require in-person visits and frequent invasive sampling if the long-term analysis is necessary.[2]
In this presentation, I will give a brief overview of our recently developed epidermal diagnostic approaches targeting various metabolites, hormones and microorganisms as well as some of skin physical and chemicals parameters to acquire better knowledge on early diagnosis and disease progression particularly for metabolic diseases and infections. This talk will summarize how to design

epidermal sensors, integrated electronics and how to use them in clinical setting with our unique access to patient materials, which creates an unprecedented opportunity to address fundamental questions in medical diagnostics.[3-4]

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Daniel T. Simon

Biography. Prof. Daniel Simon is the Organic Bioelectronics group leader at the Laboratory of Organic Electronics (LOE) at Linköping University, Sweden. Since 2011, he's led and significantly expanded organic bioelectronics at LOE, where his group poses the question: can we develop technologies that can speak both the electronic language of modern technology and the biological language of ions and molecules… and thereby enable new interfaces, understanding, and even therapies? The answer is a resounding "Yes". Using the unique properties of organic electronics his group is developing technologies for interfacing, sensing, and stimulating biological systems in their native tongue. Since 2012, this effort has been in continuous collaboration with Italian colleagues: iONE-FP7 (2012–2015), Poincaré Italy-Sweden bilateral proj. (2014–2016), HyPhOE FET-OPEN (2018–2021), visiting prof. at UNIMORE (2022), and BORGES MSCA training network (2019–2023).

Organic electronic biosensors for sustainable future healthcare

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Keywords: organic electronics, biosensors, electrolyte gated transistors

Biosensors are devices for specific analyte detection, providing an output signal that correlates to analyte concentration. A biosensor is composed of (*i*) a biorecognition element (typically an antibody, aptamer, or enzyme), which detects and binds specifically the analyte; (*ii*) a transducer that converts a physical or chemical change (typically, a binding event or enzymatic reaction) into a measurable signal; and (*iii*) the read-out, which is the processed and displayed signal. Clearly, both the specific biorecognition element and the transducing strategy affect the biosensor figures of merit: selectivity, sensitivity, and above all, dynamic range of detection. In recent years, organic electronic materials have emerged as an ideal foundation for biosensor technology, as they are amenable to functionalization with biorecognition elements, can readily transduce chemo/ionic signals into changes in electrical current, and thereby produce easily-recordable read-out. In particular, "electrolyte gated" devices such as the organic electrochemical transistor (OECT) have proven to be versatile and high-performing biosensors, as well as significantly lower-cost and

higher-throughput tools for chemical analyses.
In this talk, we will present our contribution to this field as well as our perspectives on the societal/environmental benefits of point-of-care biosensor technology.

For more, see: Burtscher, Manco Urbina, Diacci,… Simon, Bortolotti (2021) Sensing inflammation biomarkers with electrolyte-gated organic electronic transistors. *Advanced Healthcare Materials,* 10 (20) 2100955.

Eleni Stavrinidou

Biography. Eleni Stavrinidou is an Associate Professor and leader of the Electronic Plants group at Linköping University. She received a PhD in Microelectronics from EMSE (France) in 2014. She then did her postdoctoral training at Linköping University (Sweden) during which she was awarded a Marie Curie fellowship. In 2017 Eleni Stavrinidou became Assistant Professor in Organic Electronics at Linköping University and established the Electronic Plants group. She received several grants including a Swedish Research Council Starting Grant and a FET-OPEN grant which she was the coordinator. In 2020 she became Associate Professor and Docent in Applied Physics. The same year she was awarded the Future Research Leaders grant of the Swedish Foundation for Strategic Research. In 2021 she was awarded the ERC-Staring Grant. Stavrinidou is recipient of the L'ORÉAL-UNESCO For Women in Science prize in Sweden (2019) and the Tage Erlander Prize for Natural Sciences and Technology from the Royal Swedish Academy of Sciences (2023). Her research interests focus on plant bioelectronics for real time monitoring and dynamic control of plant physiology and plant-based biohybrid systems for energy and sensing applications.

Plant bioelectronics for high resolution monitoring and electronic control of plant processes

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Keywords: plant bioelectronics, sensors, actuators

The climate change and growing population calls for plants with increased tolerance to biotic and abiotic stress and plants with higher productivity. In my group we are developing organic bioelectronic technologies for sensing and actuation in plants that overcome limitations of conventional methods used in plant science but also enable new possibilities for plant interface[1]. In my talk I will present our recent advancements on interfacing bioelectronic tools with model plant systems. With miniaturized OECTs and polymeric electrodes we monitor with high resolution sugar dynamics in trees[2] and fast signaling related to movements[3] and stress responses in model plants[4]. Furthermore, we developed a flexible organic electronic ion pump for controlled delivery of phytohormones in the vasculature enabling activation of long-distance responses related to stress tolerance[5]. Finally, I will present a novel bioelectronic platform for stimulation of plant growth. Our results highlight the potential of bioelectronics in elucidating and enhancing plant processes but also for application in agriculture.

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Erica Zeglio

Biography. Erica Zeglio is an assistant professor and docent in Bioelectronic Materials at Stockholm University, Sweden. She obtained her PhD in Biomolecular and Organic Electronics from Linköping University in 2016, under the supervision of Prof. Olle Inganäs. In 2017, she moved to Australia, where she worked as an associate research fellow at the University of Wollongong under the supervision of Prof. Gordon Wallace and as an "International Postdoc" fellow in the group of Dr. Damia Mawad at the University of New South Wales (Sydney). In 2020, she returned to Sweden to continue her work as a senior researcher in HerlandLab at KTH Royal Institute of Technology. In 2023, she was appointed WISE Fellow at the Department of Materials and Environmental Chemistry at Stockholm University. She is also affiliated with Digital Futures and Karolinska Institute through the AIMES Center for Advancement of Integrated Medical and Engineering Sciences. Her group primarily focuses on sustainability issues around organic bioelectronic materials and devices. She has received several awards, including the Marie Curie Fellowship in 2021, two starting grants from FORMAS and the Swedish Research Council in 2022, and Göran Gustafsson Small Prize in technical physics in 2023.

Sustainable strategies for electrochemical transistor design

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Keywords: organic bioelectronics, organic electrochemical transistor, organic mixed conductors, direct writing

The organic electrochemical transistor (OECT) is an exciting device at the forefront of bioelectronics, with applications ranging from biosensors, electrophysiological monitoring, circuits, and neuromorphic computing.
OECT operation and performance rely on the properties of its core components, a mixed ionic/electronic conductor in contact with an electrolyte, and on the form factor that is imparted during device fabrication.[1] While tremendous efforts have been made to improve device performances, strategies that combine efficient operation and sustainable design are still lacking. To enable the transition from the laboratory to usable products, materials need to be cheap, scalable, and free from toxic precursors. Fabrication methods should enable high resolution while being affordable and allowing rapid prototyping.

In this presentation, I will discuss methods aimed at addressing these challenges. From the materials perspective, I will introduce a synthesis strategy aimed at decreasing the use of toxic precursors and I will show that blending a n-type conjugated polymer with large amounts of insulating polymer (six times more) can improve OECT performance while drastically decreasing the amount of conjugated polymer used in the blend.[2,3] Moreover, I will present a scalable method based on cleanroom-free micromachining for OECT fabrication using ultrafast laser exposure.[4] This approach enabled sub-micrometer resolution in OECT fabrication while cutting down on the steps needed with conventional manufacturing using photolithography.

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