Novel 1D photonic metal oxide nanostructures for early stage cancer detection

CanBioSe Workshop on Microfluidics and Biosystems for Personalized Medicine

Technologies for the fabrication of devices and systems at micro - and nano-scales continue to advance and diversify due to the rising demands for miniaturisation, cost reduction, functional integration and performance enhancement. This workshop will provide a broad overview of microfluidics and biosystems technologies as an enabling technology for new product development in diagnostics and in the life sciences. The workshop is a training action of the project **CanBioSe** (H2020-MSCA-RISE-2017) targeted to strengthen collaboration, sharing new ideas and knowledge transfer from research to market in the field of biosensors for cancer cells detection. The objective of the workshop is twofold: a) to share the progress in the field and b) to identify the technological orientation and future challenges offered by the connection between innovative materials and micro/ nanotechnologies. The involvement of representatives of key research disciplines will offer a podium to enable community building and networking, the sharing of progress in both technology and application development and the identification of common interests. Emphasis is put on the complete development process for microfluidics/biosystems devices, covering aspects of design, manufacturing technologies and latest trends in the personalized medicine. Application case examples will be presented as well as lessons learned during all stages of the development process of microfluidics and biosystems based devices. The workshop is organised as special session in the framework of the NanoInnovation 2018 conference (http://www.nanoinnovation.eu/2018/).

Nano 2018 Innovation Conference & Exhibition Rome, 11-14 September

CanBioSe Project

Objective

The project CanBioSe targeted to strengthen international and intersectoral collaboration, sharing new ideas and knowledge transfer from research to market and vice versa in the field of nanostructured metal oxide optical biosensors for cancer cells detection. Interdisciplinary project research and innovation goals are targeted to develop a new portable tool for early stage cancer detection which can solve on of important health challenges in EU society. One dimensional (1D) polimer nanofibers will be deposited by electrospinning technique. Photonic nanomaterials, based on metal oxide based nanostructures (ZnO, ZnO/ Al2O3 nanolaminates, Au/ ZnO and ZnO/Au) will coat the 1D nanofibers. Metal oxides and Au nanoparticles will be deposited with Atomic Layer Deposition (ALD) and electrophoresis, respectively. Bioselective layer will be formed by immobilization of specific antibodies on the biosensor surface.

Novel 1D photonic metal oxide nanostructures for early stage cancer detection

Workshop Program

Faculty of Civil and Industrial Engineering,

Sapienza University, Via Eudossiana 18 , Rome, Italy

14 September 2018 - MORNING

9.00 – 11.00 Keynote:
Advanced approaches for investigating cells and neurons (Chair. L. Lorenzelli).

The need of ever more innovative approaches for advanced diagnostics and in-vitro cell monitoring, also at single cell level, is generating a dramatic development of the technologies, boosting the interest of the research toward most powerful tools for analyzing biological samples in various fields of biomedicine, and neuroscience. In this keynote session two main achievements in this field will be presented and discussed. The first is a smart solution, based on tomographic phase microscopy (TPM) of samples at lab-on-chip scale for 3D tumor cell imaging and focused on the new paradigm of liquid biopsy. The second deals with the implementation of micro- and nanoelectronic devices emulating fundamental properties of neurons, such as action potential firing and synaptic plasticity: in this perspective a new concept of brain-machine interfacing may emerge where brain and silicon neurons are physically connected.

Pietro Ferraro, CNR - ISASI , Institute of Applied Sciences & Intelligent Systems, Pozzuoli (Napoli) Italy, (Topic: Advanced Diagnosis at single cell level by Coherent Imaging in Lab on Chip Platforms)

Stefano Vassanelli, University of Padova, Italy – (Topic: Multielectrode and Multitransistor Arrays for In Vivo Recording)

Nano Innovation 2018 Rome, 11-14 September Conference & Exhibition

CanBioSe Project

Objective—cont.

Photoluminescence and optical spectroscopy will be used for recording of the biosensor signal. Biosensor testing will be performed on cancer cells (human chronic lymphocyte leukemia (CLL) leucosis and acute lymphoblastic leucosis). The biosensor will be integrated with microfluidic system in order to minimize dimensions and simplify the use of the detection system. The project partners will provide research and training activities in the fields of nanotechnology, surface functionalization, bioengineering, microfluidics and biosensor testing, market analysis and commercialization. Provided research and management training to experienced researchers and early stage researchers will strengthen their personal skills and CVs via new scientific papers and conference theses and strengthen a development of EU research human resources.

Novel 1D photonic metal oxide nanostructures for early stage cancer detection

Workshop Program

Faculty of Civil and Industrial Engineering,

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14 September 2018 - MORNING

SESSION I

11:00-12:30 – Microfluidics concepts, technologies and applications (Chair: L. Lorenzelli, D. Erts)

Micro- and nanotechnologies for microfluidics have generated large interest in life sciences, in order to perform diagnoses and treatments at cellular and molecular level. The aim of this session is to provide main concepts in microfluidics to researchers in the area of life science and biotechnology to help them to explore this field for applications such as lab-on-a-chip, organ-on-a-chip for diagnostics. The use of diverse materials for microfluidics such as polymers, ceramics, semiconductors will be illustrated according to specific application case study. Important features like specific optical characteristics, biocompatibility issues, manufacturing technologies will be also discussed.

Donats Erts, University of Latvia, Riga, Latvia – (Topic: CanBioSe general introduction and scope of the initiative)

Andrea Adami, Fondazione Bruno Kessler, Trento, Italy – (Topic: Microfluidics for life sciences: an overview)

Tommaso Santaniello, University of Milano Bicocca - (Topic: Advanced functional polymeric materials for smart microfluidics)

Maria Lucia Curri, CNR Institute for Physical-Chemical Processes IPCF Bari Italy (Multifunctional nanomaterials based on colloidal nanoparticles for theranostic applications)

Flavio Giacomozzi, Fondazione Bruno Kessler, Trento, Italy - (Topic: Silicon-based microfabrication technologies for microfluidics)

LUNCH BREAK

Nano Innovation 2018 Rome, 11-14 September Conference & Exhibition

CanBioSe Project

Project Work Plan

WP1: Deposition and characterization of 1D photonic nanomaterials

WP2: Biosensors testing of novel photonic materials

WP3: Development of integrated microfluidic optical biosensor system

WP4: Training of early stage, experienced researchers, technicians and management staff

WP5: Project management

WP6: Dissemination of the project results and outreach activities

Novel 1D photonic metal oxide nanostructures for early stage cancer detection

Workshop Program

Faculty of Civil and Industrial Engineering,

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14 September 2018 - AFTERNOON

SESSION II

14:00-15:30 – Advances in biosensors and microfluidic devices in life science (Chair: F. Pirri, P. Siciliano)

In a lab on a chip, biosensors are important building blocks, synergic to microfluidics, because offer the possibility to perform bioanalytical investigations from different biological matrices by detecting specific and with very good sensitivity low concentrations of analytes and biomarkers. New ideas in the field of biosensors and microfluidic devices are driving technological advances in biomedical research by continuously proposing new tools for diagnostics. The aim of this session is to present to the audience possible applicative scenarios and technologies generated by the integration of biosensors and microfluidic devices combining complementary features in terms of sample management and detection capability for the next generation of miniaturized devices for life science.

Speakers:

Giuseppe Barillaro, University of Pisa, Italy - (Topic: Enabling (Bio) Sensing And (Nano)Medicine Applications Through Electrochemical Structuring of Silicon at the Micro and Nanoscale)

Corrado Di Natale, Dipartimento di Ingegneria Elettronica, Università di Roma Tor Vergata – (In-vivo and in-vitro metabolomics with porphyrins based sensor array)

Carlo A. Bortolotti, University of Modena and Reggio Emilia - (Topic: Electrolyte-Gated Organic Field Effect Transistors (EGOFETs) integrating microfluidics and electronic transduction for label-free, ultra-sensitive biosensing.)

Georg Pucker, Fondazione Bruno Kessler, Trento, Italy - (Topic: Photonic integrated sensors for life science)

COFFE BREAK

Nano 2018 Innovation Conference & Exhibition Rome, 11-14 September

CanBioSe Project

Coordinator

LATVIJAS UNIVERSITATE - Latvia

Participants

VILNIAUS UNIVERSITETAS - Lithuania

ECOLE NATIONALE SUPERIEURE DE CHIMIE DE MONTPELLIER - France

UNIWERSYTET IM. ADAMA MICKIEWICZA W POZNANIU - Poland

FONDAZIONE BRUNO KESSLER- Italy

EESTI MATERJALITEHNOLOOGIA TE ARENDUSKESKUSE AS- Estonia

BIOSENSOR S.R.L.- Italy

NANOPHARMA AS - Czech Republic

Partner organisations

Institute of Biophysics and Cell Engineering, National Academy of Sciences of Belarus

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Workshop Program

Faculty of Civil and Industrial Engineering,

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14 September 2018 - AFTERNOON

SESSION III

16:00-17:30 - Applications in personalized medicine (Chair: C. Pederzolli, L. Lorenzelli)

For the past two decades, advances in systems biology as well as micro and nanotechnologies allowed clinicians to envision personalizing the practice of medicine providing the right treatment for each patient after disease understanding and diagnosis at the molecular level. The research progresses in micro and nanotechnologies have produced innovative methods for sample processing, fluid handling and signal detection. Using integrated biomarker sensors it becomes possible to detect diseases in extremely sensitive and specific manner. Among biomarkers nucleic acids have enormous potential in non-invasive diagnostics and disease management (liquid biopsy) resulting in a great demand for accurate miRNA, mRNA, and ctDNA identification and profiling. For example, they may lead to screening of early stage cancer that is not detectable by tissue biopsy or imaging. This session will present some activities performed by research groups working in different but correlated fields such as the computational and functional oncology, the biotechnology and the biological surface science.

Speakers:

Sabrina Conoci, STMicroelectronics, Catania, ITALY – (Silicon Micro Devices and Systems for Healthcare Applications)

Giorgio Scordo, Politecnico di Torino - (Lab-on-chip for precision medicine)

Luca Francioso IMM-CNR, Lecce, Italy – (Sensors & MicroPhysiological Systems: the Organ-On-Chip case)

Francesca Demichelis, University of Trento, Centre of Integrative Biology, Laboratory of Computational and Functional Oncology (Emerging opportunities of liquid biopsies in precision oncology)

Nano 2018 Innovation Conference & Exhibition Rome, 11-14 September

CanBioSe Project

Project details

Duration:

01-01-2018 to 31-12-2021

Total cost:

EUR 1 282 500

EU contribution:

EUR 1 282 500

Coordinated in: Latvia

Topic(s):

MSCA-RISE-2017 - Research and Innovation Staff Exchange

Call for proposal:

H2020-MSCA-RISE-2017

Funding scheme:

MSCA-RISE - Marie Skłodowska-Curie Research and Innovation Staff Exchange (RISE)

Contacts

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CanBioSe Technical Project meeting

AGENDA

Date: 15 September 2018, 9.00h - 15.00h

Hosts: Dr. G. Pucker, FBK- Italy

Participants: All project members from all partners who are involved in the work package activities.

Scope: Teaming up, status of the project, next steps and milestones.

Time	Topic	Responsible
9.00-9.10	Welcome and presentation of Agenda	G. Pucker/G. Gottardi
9.10-9.15	Short introduction round	All
9.15-9.30	Overview of the status of the project	D. Erts, R. Viter
9.30-9.45	WP1 Deposition and characterization of novel photonic nanomaterials	ENSCM
9.45-10.00	WP2 Biosensor testing of novel photonic materials	Vilnius University
10.00-10.15	WP3 Development of integrated microfluidic biosensor system	FBK
10.15-10.30	**COFFE BREAK**	
10.30-10.45	WP4 Training of ESR and ER	NBMC
10.45-11.00	WP5 Project Management	D. Erts R. Viter
11.00-11.15	WP6 Dissemination of project results and outreach activities	R. Viter
11.15-11.45	Scientific Steering Committee and Management Committee Discussion about next steps	D. Erts
11.45-12.00	Actions List	D. Erts
12.00-12.30	Scheduling the project meetings	D. Erts
12.30	End of the meeting	
13.00	**LUNCH**	All

Focus on the Speakers and Abstracts—Keynote

Advanced Diagnosis at single cell level by Coherent Imaging in Lab on Chip Platforms

Pietro Ferraro

Abstract: Tomography is one of the most powerful imaging tools for analyzing biological samples, able to furnish complete mapping of the object in 3D. In particular, tomographic phase microscopy (TPM) exploits quantitative phase imaging (QPI) techniques to map the 3D refractive index (RI) of cells, by adopting laser beam deflection, direct mechanical rotation or holographic optical tweezers (HOTs) to probe the sample along a number of controlled directions. In general, all TPM set-ups require the sample to be observed along different directions with respect to the probing beam. To date, all tomographic methods require a high-precision, opto-mechanical and/or opto-electronic device to acquire a set of many images by probing the sample along a large number of controlled directions. Here we report on a smart solution to obtain TPM of samples at lab-on-chip scale, by exploiting their tumbling inside microfluidic channels. This method, recently developed, presents the following advantages: (i) Permits to observe full 360° of rotating cells, this avoiding the limitation in the accuracy of tomograms; (ii) no mechanical contact neither holographic optical tweezers are needed to rotate the sample; (iii) it is suitable for application in flowing conditions with high-throughput performances. This would allow real microfluidic biomedical applications on a large scale. The results shown in for RBCs and diatoms are here extended to quasi-spherical cells, by exploiting a new algorithm for rolling angle recovery in TPM. In particular, we performed the 3D imaging of human breast adenocarcinoma MCF-7 cells, opening the way for the full characterization of circulating tumor cells (CTCs) in the new paradigm of liquid biopsy.

Speaker: Dr Pietro Ferraro
CNR - ISASI , Institute of Applied Sciences & Intelligent Systems, Pozzuoli (Napoli) Italy
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Bio-Sketch

Pietro Ferraro received the doctor of Physics degree, summa cum laude, from the University of Napoli “Federico II”, Italy, in 1987. From 2014 is Director of Institute of Applied Sciences and Intelligent Systems "Eduardo Caianiello", Pozzuoli, National Research Council of Italy (CNR). He has worked on a number of areas in optics research ranging from laser interferometry, holography for optical characterization of materials, components and devices, including MEMS, etc.), optical fiber sensors, holographic lithography, micro- and nano-structuring of ferroelectric optical crystals (LiNbO3) for application in photonics, photorefractivity, quantitative phase-contrast microscopy by digital holography for in-vivo cells investigation, 3D imaging and display either with visible and IR laser light. In addition he is leading his group in optical microdevices and instrumentations development based on LiNbO3 such as phase-array, point-diffraction-interferometer, microfluidic structures.

Focus on the Speakers and Abstracts—Keynote

Networking brain and silicon spiking neurons with nanoscale memristors: first steps, next challenges and perspectives for brain-machine interfaces

Stefano Vassanelli

Abstract: Neural interfaces for recording and stimulation of brain neurons are experiencing a dramatic development, boosting large-scale and high-density implementations that represent an ideal bi-directional gateway to micro- and nanoelectronic devices emulating fundamental properties of neurons, such as action potential firing and synaptic plasticity. Thus, in perspective, a new concept of brain-machine interfacing may emerge where brain and silicon neurons are physically connected for seamless spike-based computation, and differently from current signal processing approaches based on Von Neumann machines. As a first step in this direction, we will present results in vitro from the RAMP project (http://www.rampproject.eu/) where nanoscale memristors are used as part of synaptic-like elements between biological and very-large integration spiking neurons. We show that memristors can mimic synapses in compressing information on spikes occurrence and with minimal power consumption and emulate plasticity across an elementary biohybrid network.

Speaker: Prof. Stefano Vassanelli
NeuroChip Laboratory – Department of Biomedical Sciences University of Padova, Italy
Email: stefano.vassanelli@unipd.it

Bio-Sketch
Stefano Vassanelli is professor of Neurophysiology at the University of Padova, Dept. of Biomedical Sciences and Padua Neuroscience Center, and leader of the NeuroChip laboratory. His main research focus is the development of novel nanotechnologies for brain-machine interfacing and for the investigation of information processing in brain microcircuits. He has coordinated the RAMP project aiming at the creation of a hybrid biological-artificial neural architecture with memristive plasticity.

Focus on the Speakers and Abstracts—Session I

Microfluidics for life sciences: an overview

Andrea Adami

Abstract: Microfluidics brings the long-standing promise of miniaturised Lab-on-a-chips (LoC) able to “miniaturise and automatize a laboratory procedure on a chip” to be used especially by unskilled operators, possibly on remote and low-resource locations. In the literature, LoC are often implemented with approaches based on labelled immunoaffinity test, label free sensors and bead-based assays, where microfluidics allow sample preparation, smallvolume testing and automatic test procedures; in addition, microfluidics are opening newopportunities and concepts by the use of micro- and nano- scale phenomena.How much commercial devices and results in the literature fulfilled the claim of userfriendliness, portability and low cost? This presentation will present a brief overview ofmicrofluidics techniques and achievements in a few case studies.

Speaker: Dr Andre Adami
FBK-CMM Center for Materials and Microsystems, Trento, Italy
Email: andadami@fbk.eu

Bio-Sketch

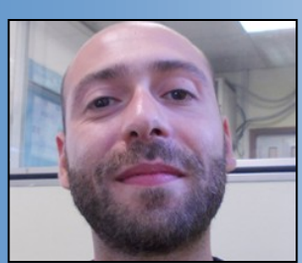
Andrea Adami (MD in Materials Engineering: 2003, PhD in ICT: 2010) is holding aresearcher position at FBK on the topic of Sensors and Microsystems since 2003.His research activities have been focused on the development of microfluidics andmicrosystems in general and in particular on the development of chemical sensors,micromechanical sensors and microfluidics for several applications.He is author of more than 70 papers in International Conferences and Scientific Journals.

Focus on the Speakers and Abstracts—Session I

Advanced functional polymeric materials for smart microfluidics

Tommaso Santaniello

Abstract: Lab-on-a-chip technologies and microfluidic devices are of strategic importance for a variety ofapplications, ranging from in vitro cell culture, to biosensing and point of care diagnostics. This talk will cover recent advances achieved at the CIMaINa laboratories in functional polymeric and nanocomposite materials design, micro-fabrication and on-chip integration for the development and prototyping of smart microfluidic systems for cell biology applications.



Speaker: Dr. Tommaso Santaniello
Interdisciplinary Centre for Nanostructured Materials and Interfaces (CIMaINa), Physics Department, University of Milan, Italy
E-mail: tommaso.santaniello@unimi.it

Bio-Sketch

Tommaso Santaniello, born in Milan, Italy, is a postdoc researcher working at the Interdisciplinary Centre for Nanostructured Materials and Interfaces (CIMAINA) in the Physics Department at the University of Milan, where he coordinates the activities on functional polymeric nanocomposites synthesis, engineerization and micro-fabrication. He obtained the PhD title in Physics and in Mechanical and Manufacturing Engineering in the framework of a Double Doctorate programme between the University of Milan and Loughborough University (U.K.). His main research interests are related to the development of soft actuators and stimuli-responsive polymeric materials, and to the design and integration of micro and nano-fabrication processes for the prototyping and production of smart structures and functional devices for biotechnology, deformable electronics and soft robotics applications.

Focus on the Speakers and Abstracts—Session I

Multifunctional Nanomaterials based on Colloidal Nanoparticles for Theranostic Applications

Maria Lucia Curri

Abstract. In the last years the extraordinary advances in the field of material science and, in particular, in nanomaterial synthesis have resulted in a great potential for biomedical applications.
A variety of preparative and post-preparative colloidal routes have demonstrated able to obtain a wide choice of inorganic nanoparticles (NPs) and nanocrystals (NCs), with different compositions, that can be achieved with a high control on size, shape and surface chemistry, ultimately tailoring their electronic, optical, magnetic, thermal and chemical size dependent properties. Functionalization strategies allowing to surface engineer NPs and NCs and to tune their specific chemical reactivity towards the surrounding environment, have enabled their conjugation and combination with biologically relevant entities, thus producing advanced materials for diagnostics and therapy.
Here the design and fabrication of specialized nanomaterials ingeniously combining suitably functionalized NPs and NCs, such as semiconductors, plasmonic and magnetic nanostructures, with peptides, drugs and other relevant biological systems will be presented and their potential for diagnosis and treatment of different diseases, including cancer and neurodegenerative diseases will be illustrated. In particular, examples of drug delivery, labelling and theranostics multifunctional systems, based on NIR photoactive nanomaterials, plasmonic nanostructures and magnetic NPs will be reported.

N. Depalo, M. Corricelli, M. L. Curri ACS Applied Materials and Interfaces, 9 (49), 43113–43126.
G. Valente, N. Depalo, M. L. Curri et al. 2016 Nano Research, 9, 644-662.
N. Depalo, N. Denora, M. L. Curri et al. 2017 Nano Research 10, 2431–2448.

Speaker: Dr. Maria Luisa Curri
Italian National Research Council CNR Institute for Physical-Chemical Processes IPCF Bari, Italy
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Bio-Sketch
M. Lucia Curri, Senior scientist IPCF CNR, Bari. PhD in Chemistry 1997 at University of Bari (Italy). Currently responsible at CNR IPCF Bari Division for the material chemistry activities aiming to design, fabricate and process inorganic solids at the nanoscale for obtaining nanostructured and multifunctional materials both for fundamental and application studies.

She is involved in development of synthetic strategies for preparation of colloidal nanocrystal based inorganic materials for photocatalytic, optoelectronic, (bio) sensing and biomedical applications.
She has been co-authoring over 200 papers, including more than 180 ISI paper, more than 150 articles on international peer-reviewed journals (JCR) and a number of other publications (10 book chapters, several conference proceedings, etc.) and has contributing to many conferences, also with invited talks (>30). Hindex 39 (Google Scholar), 35 (Web of Science).

Focus on the Speakers and Abstracts—Session I

Silicon microtechnology for microfluidics

Flavio Giacomozzi

Abstract. For many applications small quantity of fluid have to be transported, mixed or separated. Microfluidic devices can be cheaply fabricated in high volumes by using plastics but for sensing and some kind of processing silicon substrates allow much more potentiality. On chip handling of micro- or pico-liter of fluid on silicon substrate can be obtained using MEMS technology. This presentation reports about the available technology for the fabrication of microfluidic structures and more complex lab on chip devices.

Speaker: Dr. Flavio Giacomozzi
FBK-CMM Center for Materials and Microsystems, Trento, Italy
Email: giamozzi@fbk.eu

Bio-Sketch
Flavio Giacomozzi graduated in Mechanical Engineering at the University of Padova. In 1983 joined former ITC-IRST, now Fondazione Bruno Kessler (FBK), were was first involved in the improvements of surfaces properties of materials by thin film deposition and ion implantation. He contributed to the realization of the microfabrication facility and the development of fabrication processes. Since 1996, he is working mainly on the development of MEMS technologies for the realization of different kind of devices, for both research and industrial projects, like sensors, capacitive microphones, RF MEMS switches and complex circuits, microfluidic devices. He is author or co-author of numerous publication in the field of MEMS.

Focus on the Speakers and Abstracts—Session II

Enabling (Bio)Sensing And (Nano)Medicine Applications Through Electrochemical Structuring of Silicon at the Micro- and Nanoscale

Giuseppe Barillaro

Abstract: When dealing with biosensing and nanomedicine applications the length scale of targets may vary over more than 5 orders of magnitude moving from the molecular level (0.1-1 nm) up to the cell level (1-10 μm).
A number of micro and nanostructuring technologies have been developed over the years to enable the preparation of both structures and systems with length scales suitable to match specific biological targets. However, the extent to which a single technology allows the structuring of materials to be controlled over different length scales is inadequate to encompass the whole range of biological targets.
Electrochemical structuring of silicon emerges over the other micro and nanostructuring technologies as it enables the controlled preparation of structures and systems with length scale tunable over 4 orders of magnitude (from a few nanometers to tens of micrometers). In addition, high flexibility and excellent reliability of the electrochemical structuring of silicon at the micro and nanoscale makes this technology an amazing tool for the straightforward preparation of complex structures and systems for diverse applications in biosensing and nanomedicine from lab-scale development to large-scale manufacturing.
In this talk, advanced nano and microstructuring of silicon via (electro)chemical etching technology will be presented and discussed with emphasis on the preparation of structures and systems for (nano)medicine (e.g. nanopillars for cell transfection, liver on a chip, 3D microincubators for tumor cell screening) to (bio)sensing (e.g. microneedles for transdermal biosensing, optical biosensors for point-of-care clinical applications).

Speaker: Prof. Giuseppe Barillaro
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Bio-Sketch

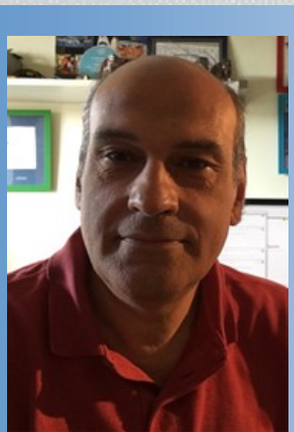
Giuseppe Barillaro is currently Associate Professor at the Information Engineering Department of the University of Pisa, where he has been leading his research group. The primary research interest of Prof. Barillaro's group is to exploit micro and nanotechnologies for the development of novel inorganic and organic materials, devices, and systems with applications in photonics, microelectronics, (bio)sensing, and (nano)medicine. G. Barillaro is author of over 200 scientific publications, among which 87 papers on peer reviewed international journals and 15 Patents.

Focus on the Speakers and Abstracts—Session II

In-vivo and in-vitro metabolomics with porphyrins based sensor array.

Corrado Di Natale

Abstract. Porphyrins have been used in the last two decades to prepare sensor arrays for a diversity of applications. The wide chemical interactivity of porphyrins sustains these applications making possible the measurement of complex patterns of volatile compounds. The interplay between the metal ion, the aromatic ring and the peripheral compounds establishes unique selectivity patterns which are fundamental elements for sensor array design and development. Porphyrin films can be adequately applied to inorganic surfaces making possible the preparation of different kinds of chemical sensors. Among them mass transducers, such as Quartz Microbalances (QMBs), have been found particularly suitable for several applications. The moderate sensitivity of the transducer avoids unpleasant effects of signal saturation. Furthermore, QMBs do not operate any selection among the interaction mechanisms giving the unique chance to appreciate and to use the whole bouquet of interactions occurring among the volatile compounds and the sensitive layers. The combination of the intrinsic porphyrins sensitivity and the transduction operated by QMB makes porphyrins sensor array able to discriminate among subtle changes in patterns of volatile compounds produced by living organisms. In-vivo, these sensors have been applied to the measure of volatile compounds released by various body compartments such as skin, breath, and urines. In breath, the identification of lung cancer has been carried out since 2003 and more recently the relationship between sensor signals and tuberculosis has been studied. In-vitro applications were concerned with the identification of cancer cells and, more recently, with the identification of the steps of stem cells differentiation has been shown. [4] Finally, it has to be mentioned the use of sensors to study the evolution of xenografted tumors and malaria infection in animal models. All these results evidence the capability of porphyrin sensor array to capture the differences in volatile compounds patterns elicited by living organisms. Similar results can be obtained by other sensors technologies; however, porphyrin sensors show a unique character of universal approach to the identification of metabolic volatiles. A suggestive explanation of this behavior considers the role of oxidative stress to the production of cancer related volatile metabolites and in particular on the role played by natural porphyrins in the oxidative stress promoted by the Cytochrome p450. In practice, a porphyrin may be active in the synthesis of the relevant compounds and other porphyrins are used to detect them.



Speaker: Prof. Corrado Di Natale
Dipartimento di Ingegneria Elettronica, Università di Roma Tor Vergata, Italy

Bio-Sketch
Corrado Di Natale is a full professor of Electronics at the Department of Electronic Engineering of the University of Rome Tor Vergata where he teaches courses on electronic devices and sensors. His research activity is concerned with the development and application of chemical and bio-sensors, artificial sensorial systems (olfaction nd taste), and the optical and electronic properties of organic and molecular materials.He authored more than 450 papers on international journals and conference proceedings (H-index=53, Scopus). He is the current president of the International Society on Olfaction and Electronic Nose and serves as editorial board member of the journals Scientific

Focus on the Speakers and Abstracts—Session II

Electrolyte-Gated Organic Field Effect Transitors (EGOFETs) integrating microfluidics and electronic transduction for label-free, ultra-sensitive biosensing.

Carlo Bortolotti

Abstract. Organic bioelectronics is a rapidly emerging field, aiming at bridging communication within biological systems to man-made electronics. One of the main fields where organic electronics is mostly impacting is biosensing. In particular, Electrolyte-Gated Organic Field Effect Transitors (EGOFETs) are emerging as an important class of chemo- and biosensors to meet the main requirements of healthcare diagnostics: portability, manufacturing with low cost, miniaturization, low-temperature processing. These devices are operated either in mode and allow for transduction of biomeolcular interactions. They can be used not only for analytical purposes, but also for real time monitoring of surface adsorption and recognition events, and may therefore provide insights into both the kinetics and thermodynamics of such non-covalent interactions. These devices provide a real-time, label-free response and the ultra-low sensitivity arising from the capacitive coupling between the electrolyte solution and the channel [2]. Integration of microfluidics into the device architecture is one crucial element to ensure in-situ functionalization, controlled sample delivery, stable environment during measurement and potentially ensure re-usability of the device interface. We recently demonstrated EGOFETs to monitor a wide range of biorecognition events, differing in terms of size of the surface bound biomolecule and of the chemical nature and lateral dimensions of the biological partner in solution, ranging from antibody/antigene (protein) and antibody/virus couples. We will also present our latest achievements in the development of a multigate lab-on-a-chip device, aiming at the multiplexed detection of different analytes in a biological fluid, also including an internal reference electrode.

Speaker: Dr. Carlo A. Bortolotti
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Bio-Sketch

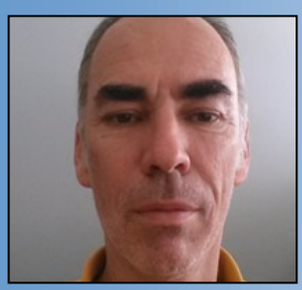
Carlo Augusto Bortolotti is Assistant Professor of Physical Chemistry at the University of Modena and Reggio Emilia. He received his PhD in Chemistry in 2006; from 2006 to 2008 he was a PostDoc at the S3 Centre (now Institute Nanoscience) of the Italian National Research Council (CNR). He has been a visiting fellow at the Brandeis University, Technical University of Denmark DTU, University College London UCL, Harvard Medical School. His current main research interests concern the development of organic electronics biosensors for investigation of biorecognition processes and label-free quantification of biomarkers in bodily fluids.

Focus on the Speakers and Abstracts—Session II

Photonic integrated sensors for life science

Georg Pucker

Abstract. In the first part of the talk a brief introduction on the principles of photonic integrated sensors applied in life science will be given. The different types of sensors disucssed will range from simple waveguide over Mach-Zehnder interferometric sensors to photonic crystal and whispering gallery mode sensors (WGM sensors). After a brief glimpse on recent progress towards single-molecule detection and commercial sensor systems a overview of FBK's research on integrated optical circuits based on silicon-oxynitride waveguides will be given. The sensing device is based on a multiple SiON microring resonators array, fiber coupled to 850 nm VCSEL and silicon photodetectors, packaged with a microfluidic circuit. The sensor fabrication and characteristics will be explained and examples on the results of sensing experiments on the toxin Aflatoxin AFM1 will be shown.



Speaker: Dr. Georg Pucker
FBK-CMM Center for Materials and Microsystems, Trento, Italy
Email: pucker@fbk.eu

Bio-Sketch
Dr. Georg Pucker is the head of the Advanced Materials and Photonic Structures research unit within the Center of Materials and Microsystems, Fondazione Bruno Kessler, Trento. He obtained his Doctoral degree in Technical Chemistry from the Technical University in Graz in 1996. Since 2001, he is researcher at the Center for Materials and Microsystems of FBK. His research in FBK ranges from silicon radiation detectors, solar cells, heterointegration of materials to silicon platforms and to integrated silicon photonics. The research in silicon photonic foccuses on the realisation of optical circuits and on the study of non-linear optical properties of silicon and silicon compatible materials.

Focus on the Speakers and Abstracts—Session III

Silicon Micro Devices and Systems for Healthcare Applications.

Sabrina Conoci

Abstract. Silicon-based devices and systems play a key role in the decentralization trend taking place in healthcare sector. Actually, silicon material offers several advantages for creating technological advancements in smart medical devices. It combines significant physical properties (such us good electrical, thermal and photo conductivity) with important technological aspects including consolidated production technologie, industrialization processes and integration of “intelligence on board” through microelectronic circuitry.

Among the several medical application fields both the molecular analysis of nucleic acids and the control of physiological parameters represents two of most important sectors, where miniaturized devices enabling portable analysis in Point-of-Care (PoC) format can give relevant improvement in the clinical utility.

In this contribution, miniaturised silicon systems of the above mentioned classes of devices are presented. In particular, the new generation of genetic PoCs based on micro electrochemical cells are described, addressing the challenge to detect nucleic acids without any amplification step (PCR free) and using electrical transuction. Finally, a miniaturized physiological probe integrating a silicon photomultipliers (SiPM) sensor for the detection of driver drowsiness through PhotoPlethysmoGraphy(PPG) signal is presented.

Speaker: Dr. Sabrina Conoci
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Bio-Sketch
Sabrina Conoci received the Master of Science in Industrial Chemistry cum laude from the University of Bologna (Italy) in 1995 and obtained her Ph.D. in Engineering of Materials from the University of Lecce (Italy) in 2001 working one year at the University of Ottawa (Canada). Since 1999, she has been with STMicroelectronics (www.st.com), Catania (Italy) ,covering several R&D positions in the field of nanomolecular Devices, Biosensors and Biotechnologies. She is currently R&D Manager of the Advanced Sensor Technologies team. She has published more than 100 papers in reputed journals, 15 international patents and more than 100 communication to international congresses.

Focus on the Speakers and Abstracts—Session III

Lab-on-chip for precision medicine

Giorgio Scordo

Abstract. Today lab-on-chips (LOCs) are considered very promising devices for the future "clinical trials on chip" as well as a step forward to design personalized medicine. LOCs make possible to exploit many different technologies, materials, and functionalizations for different purposes e.g.. purification, sensing and co-culture. In this work we have optimized the biofunctional surfaces for capturing circulating microRNAs (miRNAs), potential non-invasive cancer biomarkers, starting from a few µL biological sample. Physical, and chemical features have been optimised for these LOCs increasing the miRNA capture in the buffer sample. This methodology and device offer a new approach to study human pathophysiology of cancer detection and they may be a valid alternative to other miRNA nano capture systems requiring expensive equipment and specialized staff. also including an internal reference electrode.

Speaker: Dr. Giorgio Scordo
Chilab - Department of Applied Science and Technology, Politecnico di Torino, Torino, Italy
Email: giorgio.scordo@polito.it

Bio-Sketch
Giorgio Scordo received his BSc and MSc Degree in Biomedical Engineering at Università Federico II di Napoli and after at Campus Biomedico di Roma in 2012 and 2014 respectively. He is currently PhD student at Politecnico di Torino in Electrical, Electronic and Communication Engineering. In the last 5 years he has improve his good background in the nanotechnologies field working at CNR-IFN (Institute of photonics and nanotechnologies of Rome). General topic of his research activities are mainly focused on microfluidics, additive manufacturing, smart materials.

Focus on the Speakers and Abstracts—Session III

Sensors & MicroPhysiological Systems: the Organ-On-Chip case

Luca Francioso

Abstract. Over the past years, there has been growing interest in the development of MicroPhysiological Systems (MPSs) that are capable of recapitulating aspects of human physiology in vitro and the molecular bases of transport defects across epithelia in specific organs (due to their relevant association with diseases). The MPS devices may enhance the comprehension of disease models and improve the drug development for personalized medicine applications in vitro. The European Commission BOHEMIA study identified the "Human organ replacement" an EU research priority for 2021-2027 program; moreover, several microfluidic platforms have been developed with the goal of mimicking physiological conditions in cell culture, and the integration of sensors within these platform (e.g. Organ-On-Chip devices) usually allows higher sensitivity due to concentrated analyte availability and real-time monitoring capabilities. Among different type of devices, the microfabricated chemical and physical sensors integration is considered an urgent and challenging need of the community, because of low cost, miniaturization capability, high sensitivity/specificity and easy adoption in industrial environments for high-throughput drugs analysis.

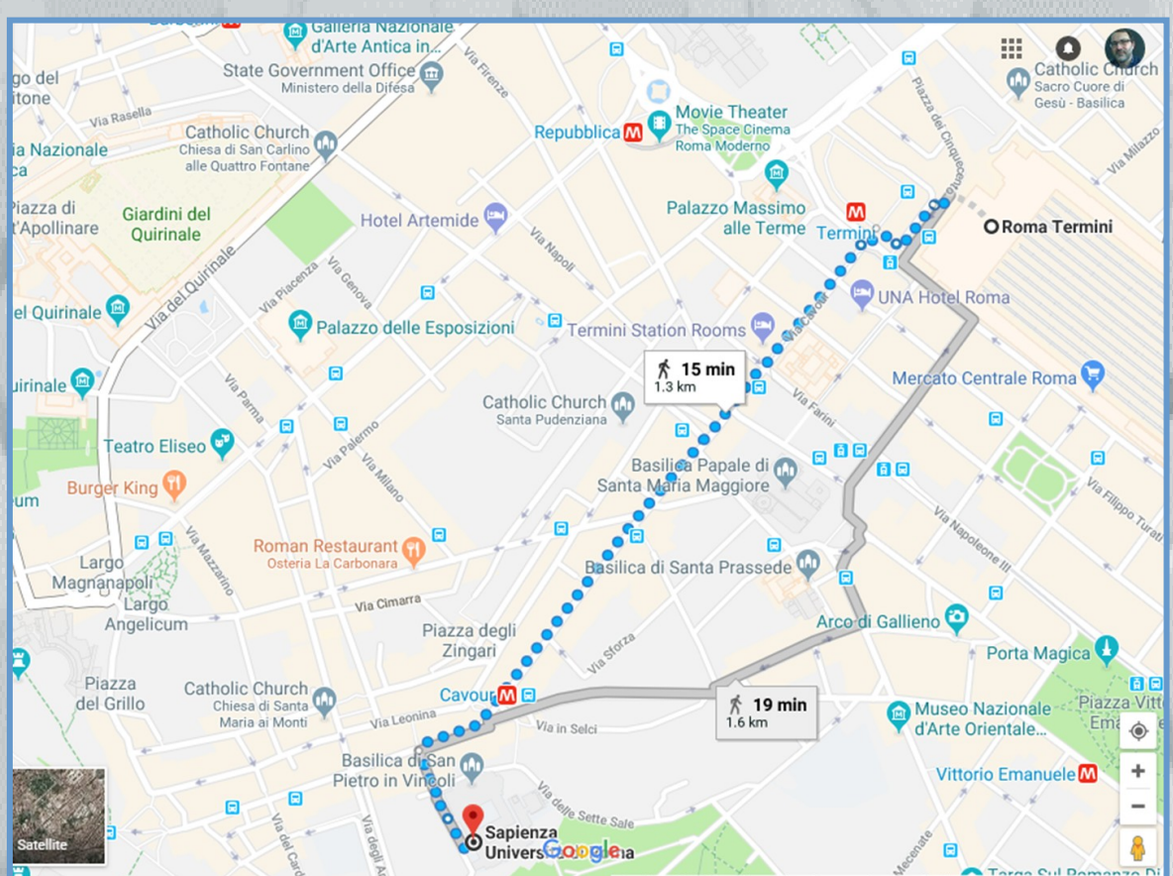
Speaker: Dr. Luca Francioso
Institute for Microelectronics and Microsystems, IMM-CNR, Lecce, Italy

Bio-Sketch

Luca Francioso received the M.Sc. degree in Physics 2001 at the University of Lecce. Since 2001 he joined the Institute for Microelectronic and Microsystems (CNR-IMM) of the National Research Council of Italy in Lecce (Italy), working in the field of silicon micromachined systems and solid state thin film chemical sensors. Since 2003 he is a permanent staff researcher, devoted to silicon technology development and MEMS devices fabrication. In 2006 he takes the PhD degree with a thesis on application of miniaturized gas sensors for combustion and cabine air quality assessment in the automotive field. Current research interests are related to: i) flexible thermoelectric and piezoelectric generators (ii) Design and manufacturing of semiconductor-based chemical sensors (iii) Organ-On-Chip platforms. He is currently responsible for the M2DCL - Multifunctional Devices Design and Characterization Laboratory at CNR-IMM in Lecce and co-authored many peer reviewed papers on national and international journals.

How to reach us

The Workshop on Microfluidics and Biosystems for Personalized Medicine, organized in the framework of NanoInnovation 2018 Conference, will be held in the main hall of the cloister of the XVI century building (a former monastery) in S. Pietro in Vincoli site of the Faculty of Civil and Industrial Engineering,Sapienza University of Rome, located in Via Eudossiana 18, in Rome on Oppio Hill. The Faculty is not far from Termini Railway Station (about 1.5 km walk) and is well connected to both airports of Rome and close to the metro B stations of Colosseo and Cavour.



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