Embassy of Italy
Stockholm

LINKÖPING
UNIVERSITY

Italy-Sweden Bilateral Workshop on
the latest sensor science and technology breakthroughs

SMART SENSOR TECHNOLOGIES AND APPLICATIONS

Innovation, strategies, and solutions
for a sustainable future

1-2 October 2024
Linköping University

Campus Valla
Studenthuset

Italy-Sweden Bilateral Workshop

Smart Sensor Technologies and Applications
Innovation, strategies, and solutions for a sustainable future

Linköping, 1-2 October 2024

Edited by

Augusto Marcelli

Donatella Puglisi

Embassy of Italy
Stockholm

LINKÖPING
UNIVERSITY

Program Day 1 - October 1, 2024

Place: Meeting Room Kronan, Studenthuset, Linköping University, *Campus Valla*

11:30 – 12:45 Registration and Lunch (*Studenthuset*)

12:45 – 13:05 Welcome & Opening
Jan-Ingvar Jönsson, Vice-Chancellor, Linköping University
Augusto Marcelli, Science Attaché, Embassy of Italy in Stockholm

13:05 – 13:30 **Edwin Jager**, Linköping University
Electroactive polymer actuators from wearable haptic devices to micromechanical stimulation of cells
13:30 – 13:55 **Costanza Toninelli**, CNR-INO Italian National Institute of Optics, Florence
Single molecules detection for enhanced sensing and quantum technologies

13:55 – 14:15 *Coffee break*

14:15 – 14:40 **Jens Eriksson**, Linköping University and VOC Diagnostics AB
Yes, we will! Make an impact through DeepTech transformation of cancer diagnostics
14:40 – 15:05 **Antonio Ciarlo**, Gothenburg University
miniTweezers2.0: smart optical tweezers for health and life sciences
15:05 – 15:25 **Niclas Roxhed**, KTH Royal Institute of Technology, Stockholm
Patient-centric sampling is the enabler for future diagnostics

Closing 1st day

15:45 *LiU Campusbussen from Universitetet to CMIV at Campus US (US Södra Entrén)* **-** *Transfer by bus*
16:20 – 17:50 Visit at the **Center for Medical Image Science and Visualization (CMIV)**

17:50 – 18:10 Walking to the City Hall (1.5 km, ~20 min)

18:10 – 19:30 **Reception at the City Hall**

Program Day 2 - October 2, 2024

Place: Meeting Room Kronan, Studenthuset, Linköping University, *Campus Valla*

9:00 – 9:15 Welcome & Opening
H.E. Michele Pala, Ambassador of Italy to Sweden

9:15 – 9:40 **Davide Esposito**, Italian Institute of Technology, Genoa
Devices for inclusion: science and technology
9:40 – 10:05 **Roberto Bresin**, KTH Royal Institute of Technology, Stockholm
Sound and music as a source of innovation
10:05 – 10:30 **Massimo Basile**, Wsense srl, Rome
Digitization of subsea infrastructures using the "Internet of Underwater Things"
10:30 – 10:55 **Lorenza Ferrario**, FBK Fondazione Bruno Kessler, Trento (online)
Acting as an Open Nanofabrication Facility, the FBK experience

10:55 – 11:15 *Coffee break*

11:15 – 11:40 **Barbara Fabbri**, University of Ferrara
Metal-oxide gas sensors: current advances in science and technology to meet challenges
11:40 – 12:05 **Qin Wang**, RISE Research Institutes of Sweden
Graphene and graphene-based hybrids for bio/chemical and industrial sensing applications
12:05 – 12:30 **Maria Rosaria Plutino**, CNR Italian National Research Council, Messina
Smart and innovative multifunctional materials: from design and synthesis to sustainable applications

12:30 – 13:45 *Lunch* (*Universitetsklubben*)

13:45 – 14:05 **Domenico Caputo**, Sapienza University, Rome
Thin and thick film technologies for smart and eco-friendly sensors and systems
14:05 – 14:30 **Yang Liu**, Linköping University
Sustainable smart manufacturing: Current reality and future prospects
14:30 – 14:55 **Olof Kordina**, Xtal-works, Vikingstad
Building bridges boosts businesses

14:55 – 15:15 *Coffee break*

15:15 – 17:00 *Roundtable*
Sensoristics: a world of technologies and applications for a sustainable future

17:00 Final and closing remarks

Edwin Jager

Biography

Edwin Jager is Professor and head of the division of Sensor and Actuator Systems. He received his M.Sc.Eng. degree (ir) in Applied Physics at University of Twente, The Netherlands in 1996, specializing in transduction science. In 2001, he received his PhD in Applied Physics at Linköping University, Sweden.

His PhD-work was continued in the spin-off company Micromuscle AB, now acquired by Creganna Medical, of which he was a co-founder and where he worked as CTO from 2000 to 2007. Micromuscle commercialized and developed medical applications of the polypyrrole actuator technology in collaboration with large medical device companies.

Thereafter, he returned to academia as assistant professor in the Organic Electronics group at the Department of Science and Technology at the Norrköping campus, focussing on Organic Bioelectronics. In the summer of 2011, he moved to the Biosensors and Bioelectronics Centre to assist building up this newly established Centre, where he became associate professor in March 2012, and which merged into the division of Sensor and Actuator Systems in 2017. He became Full Professor in Applied Physics in March 2023.

His research interests include electroactive polymers, electroactive surfaces and scaffolds, bionics, and polymer actuators for applications in textile actuators, cellular mechano-biology (mechanotransduction), medical devices and soft microrobotics.

Electroactive polymer actuators from wearable haptic devices to micromechanical stimulation of cells

Edwin Jager[1*]

[1]*Department of Physics, Chemistry, and Biology (IFM), Linköping University, Sweden*

Email: *edwin.jager@liu.se*[*]

Keywords: actuators, wearables, mechanostimulation

Ionic electroactive polymers, such as polypyrrole (PPy) and PEDOT, can be used as soft actuators from micrometre-sized robots[1, 2] and mechanostimulation devices for single cells[3] to textile actuators for macroscopic wearables.[4] They are driven at low potentials (1<V), biocompatible, and can be operated in any aqueous electrolyte, including salt solutions, full blood and cell culture medium, which makes them interesting for biomedical devices. We are developing bionic devices with a focus on biomedical applications, such as single cell mechanostimulation and bone-on-chip. Traditional microfabrication technology, including photolithography, and novel additive manufacturing methods such as 3D printing are used to create new soft microrobots comprising conducting polymer microactuators to drive the microrobots. We have developed new biohybrid materials based on gels and Plasma Membrane Nanofragments that induced bone formation.[5] By combining these new biohybrid materials with the CP microactuators we have created microrobotic devices that create their own bone. The same conducting polymers, now shaped as fibres or yarns are used to make macroscopic textile actuators, by merging advanced textile technology with conducting polymer processing.[6] Using knitting and weaving, we are developing soft textile actuators ("Knitted

Muscles") for use in wearable devices such as haptic communication garments and textile exoskeletons.

References

1. Jager, E.W.H., Inganäs, O., Lundström, I., (2000) Microrobots for micrometer-size objects in aqueous media: potential tools for single-cell manipulation, *Science*, 288, 2335-2338.
2. Tyagi, M., Spinks, G.M., Jager, E.W.H., (2020) Fully 3D printed soft microactuators for soft microrobotics. *Smart Materials and Structures*, 29, 085032 (11 pp).
3. Svennersten, K., Berggren, M., Richter-Dahlfors, A., Jager, E.W.H., (2011) Mechanical stimulation of epithelial cells using polypyrrole microactuators. *Lab on a Chip*, 11, 3287-3293.
4. Jager, E.W.H., Martinez, J.G., Persson, N.K., (2019) Textile exoskeletons. in Electroactive Polymers and Devices EAPAD 2019, Y. Bar-Cohen, Ed., SPIE: Denver, CO, USA. p. 14.
5. Cao, D., Martinez, J.G., Hara, E.S., Jager, E.W.H., (2022) Biohybrid variable stiffness soft actuators that self-create bone. *Advanced Materials,* 34(8), 2107345.
6. Maziz, A., Concas, A., Khaldi, A., Stålhand, J., Persson, N.-K., Jager, E.W.H., (2017) Knitting and weaving artificial muscles. *Science Advances*, 3(1), e1600327.

Costanza Toninelli

Biography

After a master thesis in atomic physics including one year at the Ecole Normal Superièure in Paris, and a PhD in nanophotonics and complex systems in Florence, she is a postdoc fellow at ETH in Zürich, studying single molecule spectroscopy. Costanza then receives the Caroline von Humboldt prize in 2011 and becomes Researcher at INO-CNR and group leader at LENS. In 2023 Costanza is awarded the ERC consolidator grant for the project QUINTESSEnCE. Her interest focuses on the development of quantum technologies based on the coupling between single-molecule based quantum emitters to nanostructured materials, yielding on-chip single photon sources as well as quantum sensors. She also likes to play with light transport in complex systems and fluorescence-based sensors.

Single molecules detection for enhanced sensing and quantum technologies

Costanza Toninelli[1,2*], Hugo Levy-Falk, Rocco Duquennoy[1,3], Ramin Emadi[1,3], Daniele De Bernardis[1,2], Maja Colautti[1,2], Mario Agio[1,4]

[1]*National Institute of Optics (CNR-INO), Via Nello Carrara 1, Sesto F.no 50019, Italy*
[2]*LENS, Via N. Carrara 1, Sesto F.no, Italy*
[3]*Physics Department, University of Naples, via Cinthia 21, Fuorigrotta 80126, Italy*
[4]*Department of Physics, Siegen University, Siegen Germany*

Email: *toninelli@lens.unifi.it*[*]

Keywords: fluorescence sensing, single molecule, quantum states of light

In my contribution, I will show how the manipulation of single molecules in solids is a key resource for disruptive technologies, ranging from quantum communication and sensing to fluorescence diagnostics.
Single organic molecules in the family of polycyclic aromatic hydrocarbons (PAH), embedded in suitable host matrices, offer competitive properties and key advantages [1]. Being very small and with well-defined transition dipole moments, they can be used as nanoscopic sensors e.g. of pressure, strain, temperature, electric and magnetic fields, as well as optical fields. Furthermore, PAH molecules can be easily fabricated and exhibit strong zero-phonon lines, which reach their Fourier-limited natural linewidth at liquid helium temperature, thus providing very bright and stable sources of coherent photons in the solid state [2,3,4].
I will present our recent advances on the use of these molecules as single photon sources for photonic quantum technologies [5,6]. In particular, I will show how it is possible to use the non-classical photon statistics for the distribution of a secret key over long distances [7]. Then we will discuss the prospects for scaling up the operations on chip.
Additionally, the presentation explores the use of organic molecules as nanoscopic thermal sensors, enabling semi-invasive local temperature measurements in a temperature range (3 K to 30 K) unattainable by most commercial technologies. These results offer insights into the local phononic environment in complex structures and an unexplored temperature regime [8].
Finally, I will show how pushing the efficiency in the photon extraction can be vital in fluorescence diagnostics. Here, we present a planar antenna that is able to redirect the emission

of fluorophores thereby decreasing the limit of detection for sepsis CRP biomarker to 1.5 ng/mL, showing a 50x enhancement with respect to the case of standard glass chips. This is attained in a lensless fiber microscope (shown in the figure below), that has been prototyped for such application [9].

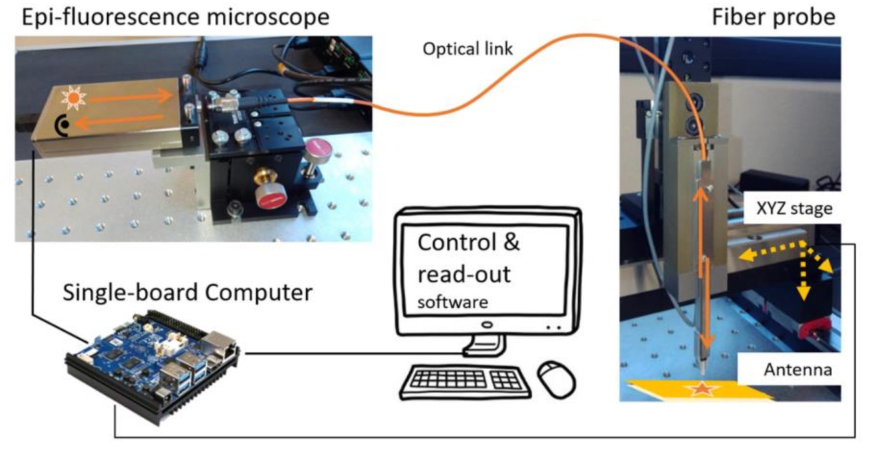


Figure 1. Schematic drawing of the installation for enhanced fluorescence detection. The whole setup fits in a 30-cm size plexiglass cage.

References

1. Toninelli, C., Gerhardt, I., Clark, A.S., Reserbat-Plantey, A., *et al*., (2021) Single organic molecules for photonic quantum technologies. *Nature Materials* 20, 1615-1628.
2. Pazzagli, S., Lombardi, P., Martella, D., Colautti, M., *et al*., (2018) Self-Assembled Nanocrystals of Polycyclic Aromatic Hydrocarbons Show Photostable Single-Photon Emission. *ACS Nano* 12(5), 4295-4303.
3. Lombardi, P., *et al*., (2020) *Ad.Q.Tech*. 3
4. Colautti, M., *et al*., (2020) *Ad.Q.Tech*. 3
5. Duquennoy, R., Colautti, M., Emadi, R., Majumder, P., Lombardi, P., Toninelli, C., (2022) Real-time two-photon interference from distinct molecules on the same chip. *Optica* 9(7), 731-737.
6. Colautti, M., Piccioli, F., Ristanović, Z., Lombardi, P., Moradi, A., *et al*., (2020) Laser-Induced Frequency Tuning of Fourier-Limited Single-Molecule Emitters. *ACS Nano* 14(10), 13584−13592.
7. Murtaza, G., Colautti, M., Hilke, M., Lombardi, P., *et al*., (2022) Efficient room-temperature molecular single-photon source for quantum key distribution. *Optics Express* 31(6), 9437-9447.
8. Esteso, V., Duquennoy, R., Ng, R.C., Colautti, M., *et al*., (2023) Quantum Thermometry with Single Molecules in Nanoprobes. *PRX Quantum* 4(4), 040314.
9. Esteso, V., Lombardi, P., Chiavaioli, F., Majumder, P., Colautti, M., Howitz, S., Cecchi, P., Baldini, F., Giannetti, A., Toninelli, C., (2023) Enhanced Fluorescence in a Lens-Less Fiber-Optic Sensor for C-Reactive Protein Detection. *Chemosensors* 11(8), 448.

Jens Eriksson

Biography
Associate professor in applied physics. CTO of VOC Diagnostics. After a PhD in materials science, I have worked mostly with research on 2D materials and environmental sensors. Since 2021 my focus has shifted to life science applications of sensors, especially commercial development of diagnostic instruments based on chemical sensors.

Yes, we will! Make an impact through DeepTech transformation of cancer diagnostics

Jens Eriksson[1,2*], Ivan Shtepliuk[2], Christer Borgfeldt[3], Donatella Puglisi[2]

[1]*VOC Diagnostics AB, Linköping, Sweden*
[2]*Linköping University, department of physics, chemistry and biology, Linköping, Sweden*
[3] *Department of Obstetrics and Gynecology, Skåne University Hospital (SUS), Lund University, Sweden*

Email: *jens.eriksson@liu.se*[*]

Keywords: cancer, diagnostics, electronic nose,

The concept of electronic noses was first introduced in the 80s. Already in the early 2000s a group of chemists at the university of Illinois demonstrated the first e-nose application in diagnostics when they showed a colorimetric assay based on color dyes [1] that was later used to detect lung cancer (along with other conditions) in breath. However, despite some liberal representations as detect-all-things-in-all-scenarios on shows like CSI, e-noses have struggled to reach practical implementations in society. Rapid advances in several machine learning toolboxes and programming platforms, along with improved sensor hardware, have removed several of the main obstacles, whereby the time for efficient and practical use of e-noses is now!

Here we introduce an e-nose for use in cancer diagnostics based on odor detection from 1 ml of blood(plasma). It’s raison d'être is early detection of ovarian cancer, one of the “silent killers”, but the technology can be applied also to other cancer types and diseases.

Endogenous volatile organic compounds (VOCs) are products of metabolic activity. Metabolite concentrations are affected by tumor necrosis, resulting in cancer-specific VOC patterns. The results shown here are from measurements of 169 blood samples from cancer patients (124 ovarian cancer patients and 45 endometrial cancer patients in stages I – IV) together with 161 negative controls.

Instrument: 32 MOX sensors (TGS2X series) are arranged in four banks at different temperatures. Samples (liquid, 1 ml) are placed in a holder which is inserted into the e-nose at the start of a measurement. After an initial equilibration step where VOCs are emitted from the sample into the headspace of the instrument, a fan downstream moves the VOCs over the sensors. The sensor signals are logged at 10 Hz for ten minutes per measurements.

How the sensor data is processed to determine the nature of the sample is critical for the final performance and for fidelity. Here, preprocessing, feature extraction, classifier training and testing, were performed independently by different teams. Three independent approaches all show overall accuracies higher than 98%. The results of binary classification as either "cancer" or "healthy" based on 85 features and a random forest classifier are shown in Figure 1. Additional classifiers were implemented sequentially for further division into cancer type and stage, allowing distinguishing ovarian cancer stage I with a sensitivity of 98.5%.

There are currently no viable screening methods available for ovarian cancer, which is often non-symptomatic even to stage IV, resulting in a very poor prognosis upon diagnosis. A reliable, rapid (10 min), diagnostic test could save many lives, with associated socio-economic benefits.

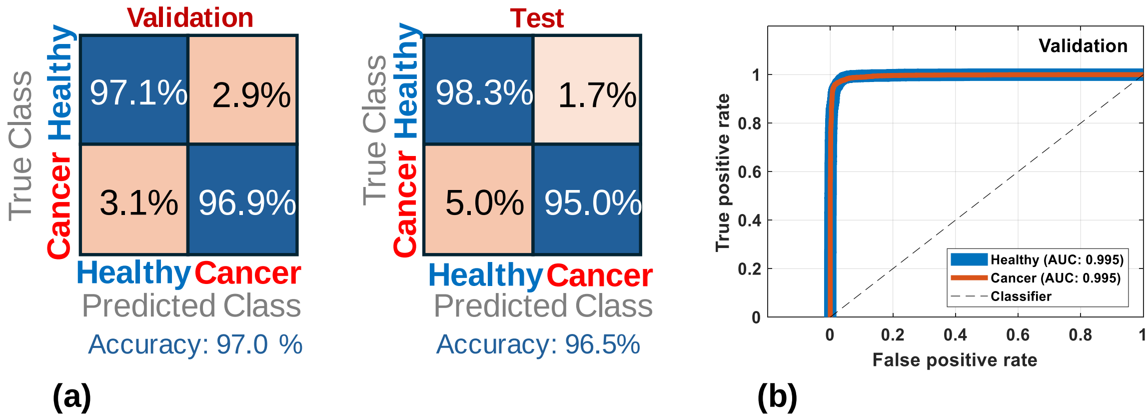


Figure 1. Confusion matrices (a) pertaining to 169 cancers (124 OC and 45 EC) and 161 negative controls using 10-fold cross validation (left panel) and omitting 25% of the data during training for testing (right panel); the ROC-AUC (b) during validation.

References

1. Rakow, N., Suslick, K., (2000) A colorimetric sensor array for odour visualization. *Nature* 406, 710–713.

Antonio Ciarlo

Biography

Antonio Ciarlo is a physicist with expertise in optics, optical trapping, diffusion process analysis, artificial intelligence, and manipulation of microparticles. He is a postdoctoral researcherat the Soft Matter Lab within the Physics Department at the University of Gothenburg. Currently, his research involves studying non-trivial diffusion processes using a random force field, investigating inertial effects on particles trapped in air, developing an optical tweezers system utilizing artificial intelligence to perform experiments autonomously, and exploring new exotic optical tweezers setups.

miniTweezers2.0: smart optical tweezers for health and life sciences

Antonio Ciarlo[1*], Martin Selin[1], Giuseppe Pesce[2,1], Lars Bengtsson[1], Joan Camunas- Soler[3,4], Vinoth Sundar Rajan[5,6], Fredrik Westerlund[5], L. Marcus Wilhelmsson[6], Isabel Pastor[7,8], Felix Ritort[7,8], Steven B. Smith[9], Carlos Bustamante[10,11,12,13,14,15,16], Giovanni Volpe[1]

[1]*Physics Department, University of Gothenburg, 412 96 Gothenburg, Sweden* [2]*Department of Physics, Università degli studi di Napoli "Federico II" ComplessoUniversitario Monte S. Angelo, Via Cintia, 80126 Napoli, Italy*
[3]*Department of Medical Biochemistry and Cell Biology, Institute of Biomedicine,University of Gothenburg, Gothenburg 405 30, Sweden*
[4]*Wallenberg Centre for Molecular and Translational Medicine, Sahlgrenska Academy,University of Gothenburg, 405 30 Gothenburg, Sweden*
[5]*Department of Life Sciences, Chalmers University of Technology, 41296 Gothenburg,Sweden*
[6]*Department of Chemistry and Chemical Engineering, Chalmers University ofTechnology, 41296 Gothenburg, Sweden*
[7]*Small Biosystems Lab, Condensed Matter Physics Department, University of Barcelona, 08028 Barcelona, Spain*
[8]*Institut de Nanociència i Nanotecnologia (IN2UB), Universitat de Barcelona,Barcelona 08028, Spain*
[9]*Steven B. Smith Engineering, Los Lunas, New Mexico, USA*
[10]*Department of Molecular and Cell Biology, University of California, Berkeley,Berkeley, CA 94720, USA*
[11]*California Institute for Quantitative Biosciences, University of California, Berkeley,Berkeley, CA 94720, USA*
[12]*Jason L. Choy Laboratory of Single-Molecule Biophysics, University of California,Berkeley, Berkeley, CA, USA*
[13]*Department of Physics, University of California, Berkeley, Berkeley, CA, USA* [14]*Howard Hughes Medical Institute, University of California, Berkeley, Berkeley, CA,USA*
[15]*Kavli Energy Nanoscience Institute, University of California, Berkeley, Berkeley, CA,USA*
[16]*Department of Chemistry, University of California, Berkeley, Berkeley, CA, USA*

Email: *antonio.ciarlo@physics.gu.se*[*]

Keywords: optical tweezers, automation, life-science

Optical tweezers have become indispensable tools in various scientific fields such as biology, physics, chemistry, and materials science. Their wide range of applications has attracted the interest of scientists with limited expertise in opticsand physics. Therefore, it is crucial to have a system that is accessible to non- experts. In this study, we present miniTweezers2.0, a highly versatile and user- friendly instrument enhanced by artificial intelligence. We demonstrate the

capabilities of the system through three autonomous case study experiments, as shown in Figure 1. The first is DNA stretching, a fundamental experiment in single-molecule force spectroscopy [1]. The second experiment focuses onstretching red blood cells, providing insight into their membrane stiffness [2]. The final experiment examines the electrostatic interactions between microparticles in different environments [3]. Our results highlight the potential of automated, versatile optical tweezers to advance our understanding of nanoscale and microscale systems by enabling high-throughput, unbiased measurements.
The miniTweezers2.0 system successfully demonstrates the integration of artificial intelligence and automation to make optical tweezers more accessible and versatile, especially for health and life sciences. The adaptability of miniTweezers2.0 underscores its potential as a powerful tool for future scientificexploration across multiple disciplines.

a) b) c)

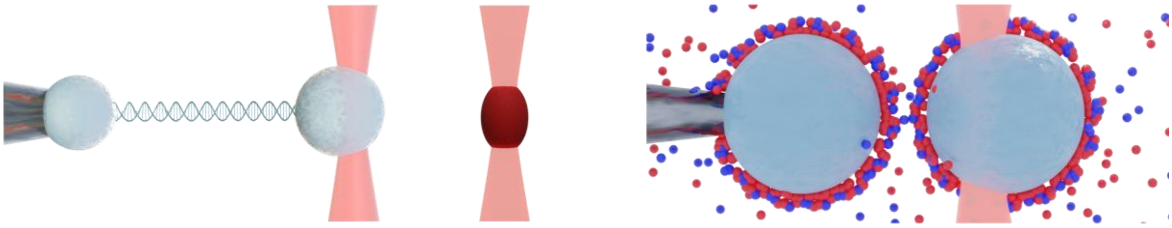


Figure 1. Schematic representation of the case study experiments. a) Stretching a singleDNA molecule, where the red beam represents the trapping laser, and the two light bluespheres represent particles between which a DNA molecule is attached. b) Stretching a single red blood cell. c) Measuring the electrostatic interaction between two particles, where the red circles around the particles represent the cations and the blue ones the anions.

References

1. Smith, S.B., Cui, Y., Bustamante, C., (1996) Overstretching B-DNA: the elastic response of individual double-stranded and single-stranded DNA molecules. *Science*, 271 (5250), 795-799.
2. Mills, J.P., Qie, L., Dao, M., Lim, C.T., Suresh, S., (2004) Nonlinear elastic and viscoelastic deformation of the human red blood cell with optical tweezers. *Molecular & Cellular Biomechanics*, 1(3), 169.
3. Gutsche, C., Keyser, U.F., Kegler, K., Kremer, F., Linse, P., (2007) Forces between single pairs of charged colloids in aqueous salt solutions. *Physical Review E—Statistical, Nonlinear, and Soft Matter Physics*, 76(3), 031403.

Niclas Roxhed

Biography

Niclas Roxhed is Associate Professor and a team leader of biomedical microsystems at KTH Royal Institute of Technology, Stockholm, Sweden and an affiliated researcher with Bob Langer's lab at the Koch Institute of Integrative Cancer Research at MIT in Boston, USA. He is the director for MedTechLabs, a joint KTH/Karolinska Institutet/Region Stockholm interdisciplinary center for translational medical technology. He is a member of the international steering committees of the Microneedle conference, the IEEE MicroElectroMechanical Systems conference and was the general co-chair of IEEE MEMS 2021, and an editor of the IEEE Journal of Microelectromechanical Systems. He is initiator and co-founder of the blood microsampling company Capitainer and several other startups. His main research fields are microneedles, microsystems for medical diagnostics, and MEMS-based drug delivery systems. Dr. Roxhed has authored more than 150 scientific papers and is an inventor of over 40 patents.

Patient-centric sampling is the enabler for future diagnostics

Niclas Roxhed[1,2*], Claudia Fredolini[3], Olof Beck[4], Jochen Schwenk[3]

[1]*Micro and Nanosystems, School of Electrical Engineering and Computer Science, KTH Royal Institute of Technology Stockholm, Sweden*
[2]*MedTechLabs, BioClinicum, Karolinska University Hospital, 171 64 Solna, Sweden*
[3]*Science for Life Laboratory, School of Engineering Sciences in Chemistry, Biotechnology and Health, KTH Royal Institute of Technology, 171 65 Solna, Sweden*
[4]*Department of Clinical Neuroscience, Karolinska Institutet, 171 77 Stockholm, Sweden*

Email: *roxhed@kth.se*[*]

Keywords: microsampling, proteomics, healthcare

Patient-centric sampling strategies, where patients collect their samples themselves at home and ship them to a healthcare facility gained enormous attraction during the covid-19 pandemic. With obvious merits such as convenience, simplicity and avoiding loading and exposing healthcare facilities, these sampling strategies were predominantly employed for viral nucleic acid testing in sputum and pharyngeal samples. However, patient-centric serological testing of blood was also implemented in Sweden.
Recent advancements in advanced molecular analysis techniques have pushed sensitivities to extreme levels where only tiny samples are sufficient for analysis. By simplifying the sampling procedure, we can leverage on these new advancements and obtain better insights into biological procedures than before. These new methodologies will be essential in future diagnostics and guide pharmaceutical interventions in the future.

Davide Esposito

Biography
Davide Esposito graduated in bioengineering (BSc) at Politecnico di Torino in 2015 and in bionics engineering (MSc) at Università di Pisa and Scuola Superiore Sant'Anna in 2018. He then entered the IIT-UVIP group, led by Dr. Monica Gori, as PhD student, where he obtained his PhD in 2022 studying how the brain encodes space at different ages and in different populations (e.g. young children, visually impaired individuals, psychiatric patients). He is currently post-doc in the IIT-UVIP, where he contributes to the coordination of multiple projects on the use of technology to foster inclusion in urban environments. He is also involved in the startup project SoBu, trying to bring on the market the results of the IIT-UVIP scientific production.

Devices for inclusion: science and technology

Davide Esposito[1*], Alice De Luca[1], Monica Gori[1]

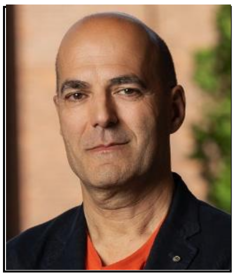
[1]*Unit for Visually Impaired People, Fondazione Istituto Italiano di Tecnologia, Genoa, Italy*

Email: *davide.esposito@iit.it*[*]

Keywords: visual impairment, inclusion, multisensory integration

In 2014, the number of blind children below 15 years was estimated to be 19 million. Research is for the people, and it should be accessible. In the past 20 years, the Unit for Visually Impaired People of IIT have worked to understand child development and find new science-based technological solutions by joining psychology, neurophysiology, and technology. In our work, we have found a new connection by studying the multisensory development of children and understanding the deficits and mechanisms that can lead to the reorganization of behavior and brain function. We have designed, developed, validated, and proposed for commercialization new multisensory systems such as ABBI and, more recently, SOBU. These are the first multisensory technologies for easy, intuitive, and accurate stimulation of space and body representations in visually impaired children and adults. In this talk we will present ABBI and SOBU and new VR devices and applications for visually impaired children. We will also present the work done within the RAISE project that aims to improve the quality of life and inclusion of individuals in urban settings. Working at the intersection of neuroscience and technology, the current goal of the UVIP work is to move towards earlier intervention, even within the first three years of life and to breakdown the barriers for all.

Roberto Bresin



Biography
From the KTH Royal Institute of Technology, Roberto is working as Professor of Media Technology at the Division of Media Technology and Interaction Design (MID), School of Electrical Engineering and Computer Science (EECS), since 2014, and he has been heading the Sound and Music Computing group. He is the Director of Studies for the KTH Master of Science in Engineering, Degree Programme in Media Technology. Since June 2019, he has been the Director of NAVET, a KTH centre for research in the intersection of art, technology and design, including schools of art, design and museums. His main research interests are expressive music performance, emotion in sound and music performance, sound in interaction, robot sound design, and sonification. For more information, please visit Roberto's profile page at KTH: https://www.kth.se/profile/roberto

Sound and Music as a Source of Innovation

Roberto Bresin[1*]

[1]*KTH Royal Institute of Technology, Stockholm, Sweden*

Email: *roberto@kth.se*[*]

Keywords: emotions, sonification, interaction

During this talk, I will introduce some projects which stem from basic research results in two fields: communication of expression in music performance and data sonification. In previous studies, we have shown how expression, including emotions, can be communicated with music and sound by manipulating some acoustical parameters, and how the relationship in data sets, for example of physical parameters, can be achieved by mapping them to specific acoustical categories through sonification [1,2].

Projects that I will briefly introduce include some of the following ones: the Sound Forest – a large-scale Digital Musical Instrument (DMI) situated at the Swedish Museum of Performing Arts in Stockholm [3], applications of sound design for humanoid robots [4], Nebula – an interactive garment designed for functional aesthetics [5], interactive sonification of spontaneous movement of children [6], sound feedback for best body posture in running [7], sonification of computer shutdown and idle mode [5], communication of climate change data through sonification and dance, and the impact of vessel traffic on the Baltic Sea environment [8].

References

1. Bresin, R., Friberg, A., (2011) Emotion rendering in music: Range and characteristic values of seven musical variables. *Cortex* 47(9), 1068-1081.
2. Dubus, G., Bresin, R., (2013) A Systematic Review of Mapping Strategies for the Sonification of Physical Quantities. PLOS ONE 8(12), e82491.
3. Frid, E., Lindetorp, H., Hansen, K.F., Elblaus, L., Bresin, R., (2019) Sound Forest - Evaluation of an Accessible Multisensory Music Installation. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems.* (pp. 1-12). ACM.

4. Latupeirissa, A.B., Panariello, C., Bresin, R., (2023) Probing Aesthetics Strategies for Robot Sound: Complexity and Materiality in Movement Sonification. *ACM Transactions on Human-Robot Interaction* 12(4), 1-22.
5. Panariello, C., Bresin, R., (2022) Sonification of Computer Processes: The Cases of Computer Shutdown and Idle Mode. *Frontiers in Neuroscience* 16, 862663.
6. Frid, E., Bresin, R., Alborno, P., Elblaus, L., (2016) Interactive Sonification of Spontaneous Movement of Children: Cross-Modal Mapping and the Perception of Body Movement Qualities through Sound. *Frontiers in Neuroscience* 10, 521.
7. Bolíbar, J., Bresin, R., (2012) Sound feedback for the optimization of performance in running. *TMH-QPSR special issue: Proceedings of SMC Sweden 2012 Sound and Music Computing, Understanding and Practicing in Sweden,* 52(1), 39-40.
8. Hultman, A., Mancini, M., Bresin, R., (2024) Interactive sonification helps make sense of the negative environmental impact of vessel traffic in the Baltic Sea. In *Proceedings of Audio Mostly 2024*, ACM.

Massimo Basile

Biography
Massimo Basile is currently collaborating with WSense as Senior Manager.
From 2018 to 2023 Massimo worked at Leonardo Corporate as Chief Commercial Officer with responsibility for International Marketing and Strategic Campaigns for Northern Europe and the Baltic States, covering the complete Leonardo's portfolio throughout the products and solutions of all Leonardo Divisions and the Subsidiaries.
From 2012 to 2018 Massimo led the Cyber Services & Solutions Italy Business Area of Selex ES and the Cyber & ICT International Sales Unit of Leonardo SpA with worldwide sales responsibility for Cyber & ICT solutions.
As Head of the Cyber Services & Solutions Italy Business Area of Selex ES he was responsible for the Managed Security Services of Selex ES, with the fundamental assets of the Security Operation Centers (SOC) in Italy and of the High Performance Computer (HPC) for Open Source Intelligence (OSINT). He was also managing the advanced cyber technologies developments, based in Milan, Italy.
Throughout his 40+ years careers, Massimo had significant experiences abroad in the technical, sales and management domains, including the management of Selex ES subsidiaries Companies (formerly Marconi) based in Romania and in Germany. From 2007 to 2012 he was appointed as Sole Administrator of Selex Communications Romania and Chairman and Member of the Board of Directors of Elettra Communications, Ploiesti, Romania. From 2002 to 2007 he was appointed as Regional Sales Manager of Selex Communications, formerly Marconi, with responsibility for Northern Europe and the Baltic States. Massimo had the first professional experience in the Northern Europe in 1990 as Telecommunications System Engineer at Marconi.

Digitization of subsea infrastructures using the "Internet of Underwater Things"

Massimo Basile[1*]

[1]*Wsense s.r.l., 00198 Rome, Italy*

Email: *massimo.basile@wsense.it*[*]

Keywords: underwater Internet of Things

WSense places itself at the center of the entire ocean data ecosystem, as an "enabler" of the Blue Economy supply chain: through revolutionary proprietary technology, it offers the backbone on which to build a future sustainable and interconnected ocean ecosystem, based on continuous connectivity and real-time data exchange.
WSense's technologies enable the implementation of "Underwater WiFi" to connect robotics, sensors, actuators, and professional divers into a single unified communication ecosystem, to provide support for the underwater domain control and critical infrastructures' protection.
WSense's underwater "Internet of Things" systems are "wireless observatories", easily deployable, capable of continuously monitoring, launching alarms and providing real-time data not only on the water column in the coastal area but also up to 3000 meters deep on various aspects and parameters - from biodiversity, to noise, to the solidity of structures located in a marine environment.
WSense platforms are Sensor Agnostic IoUT.

These systems can find application in all areas of the Blue Economy: study and protection of biodiversity and climate change, optimization of production processes in the context of the energy transition, environmental monitoring and protection of critical infrastructures.

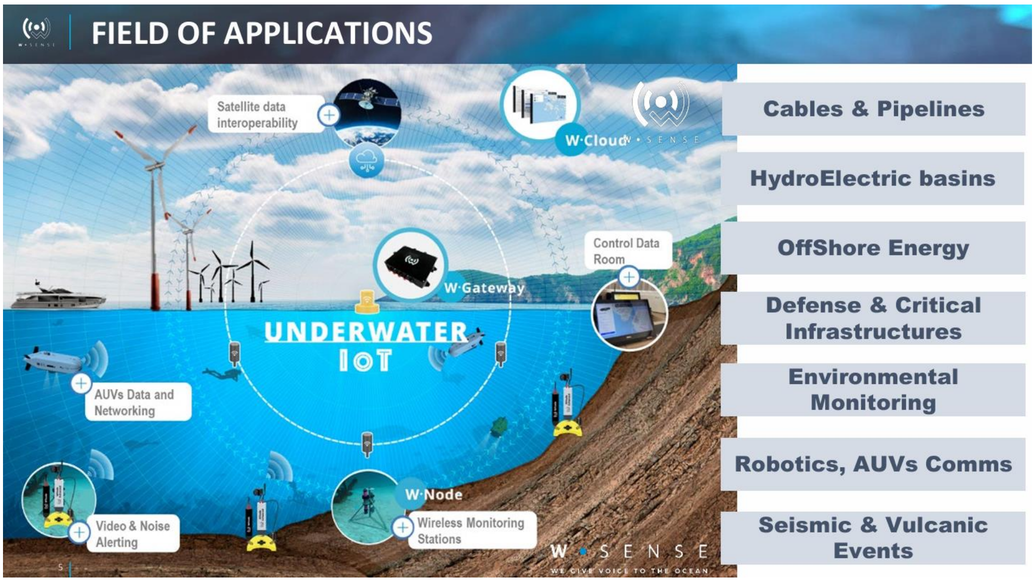


Figure 1. WSense field of applications overview.

Examples of field of applications are:

- Noise monitoring
- Marine conditions monitoring (waves, tiles, currents, temperature, etc.)
- Environmental/ geochemical/ pollution monitoring (e.g. chlorophyll, bacteria, pH, Dissolved oxygen, Salinity, etc.)
- Real-time data and monitoring of hazardous gases, methane and currents (CO_2), salinity, and volcanic activity
- Early warning systems based on infrastructure sensors (vibration, accelerometer, inclinometers) to provide real-time structural monitoring for bridges, dames, and ports
- Underwater critical infrastructure monitoring
- ROVs/AUVs real-time underwater connectivity

As July 2024, WSense underwater developments include:

- 1,6 million real-time transmitted datapoints
- 24 monitored areas from Northern Norway to Mediterranean and Red Sea
- 37 measured water and infrastructure parameters

Lorenza Ferrario

Biography
Lorenza Ferrario received the Master Degree in Statistical Sciences from the University of Bologna, and the PhD degree in Engineering Sciences from the University of Freiburg, Germany. At the Fondazione Bruno Kessler, she is head of the Micro Nano Facility, managing the 4 semiconductor cleanrooms and the other laboratories for sensors characterization and integration. In this role, she keeps developing new access policies and models to increase access opportunities for academic organization and industries. Lorenza Ferrario is the coordinator of the IPCE ME project at FBK, managing the development of the 3D integration technology.

Acting as an Open Nanofabrication Facility, the FBK experience

Lorenza Ferrario[1*]

[1]*Fondazione Bruno Kessler 1, Trento, Italy*

Email: *ferrario@fbk.eu*[*]

Keywords: semiconductor, sensors, pilot line, open access facility

This talk will present MNF, the Micro-Nanon Facility of the Fondazione Bruno Kessler, and its role in enabling state of the art research as well as industrial innovation in micro-nanoelectronics and nanotechnologies.
The evolution from "pure" research laboratory to Open Facility, unique at National level: from ISO 9001-2015 certification, to guarantee research on silicon sensors and MEMS happily living together with small prototype production. The continuous improvement of the technology, from the 1990 first cleanroom, to the current facility, including 4 cleanrooms and laboratories completing the "value chain" from sensor fabrication to integration setup to develop fully functional prototypes.

The evolution of the facility will also be presented in terms of access policies, to manage quality, safety, and IP, in consideration of the numerous collaborations with companies. A 360^o perspective, with attention not only to research and technology, but also to organization, accounting, quality, and sustainability. The presentation will end with some considerations about involvement of FBK in recent strategic European actions: IPCEI projects, Chips Act Pilot Lines.

Barbara Fabbri

Biography

Dr. Barbara Fabbri obtained her Master's degree (2011) and PhD (2015) in Physics at the University of Ferrara. She has experienced since more than ten years with gas sensing technology at the Department of Physics and Earth Sciences, working on the key factors involved in gas sensors research, i.e. innovative sensing materials, their characterization by advanced techniques and their application, from environmental monitoring to medical diagnosis and precision agriculture. She is author of 40 peer-reviewed articles (H-index 18) and she was recently awarded with the Eurosensors fellow 2024.

Metal-oxide gas sensors: current advances in science and technology to meet challenges

Barbara Fabbri[1*], Elena Spagnoli[1], Arianna Rossi[1], Emanuela Tavaglione[1], Vincenzo Guidi[1]

[1]*Department of Physics and Earth Sciences, University of Ferrara, via Saragat 1/C, 44122, Ferrara, Italy*

Email: *barbara.fabbri@unife.it*[*]

Keywords: metal-oxide semiconductors, chemoresistive gas sensors, room-temperature operation, operando techniques, DRIFT spectroscopy

Due to their tunable physico-chemical properties and their robustness, metal oxides (MOXs) are still the most used functional materials for fabrication of solid-state gas sensors. However, several attempts have been pursued to increase their sensitivity exploiting the broad palette of precursors and synthetic techniques that enable MOX properties to be tailored. Moreover, the development of humidity-independent devices for atmospheric real-time gas measurements is extremely challenging because water can easily yield hydroxyl groups, negatively affecting the electrical properties of the sensitive film while limiting target gas adsorption. Additionally, the low selectivity of standard MOX sensors, induced by kinetic competition in redox reactions between different gaseous species on the surface-active sites, is a crucial obstacle for the detection of the analyte in gas mixtures, especially when present at sub-ppm concentrations.

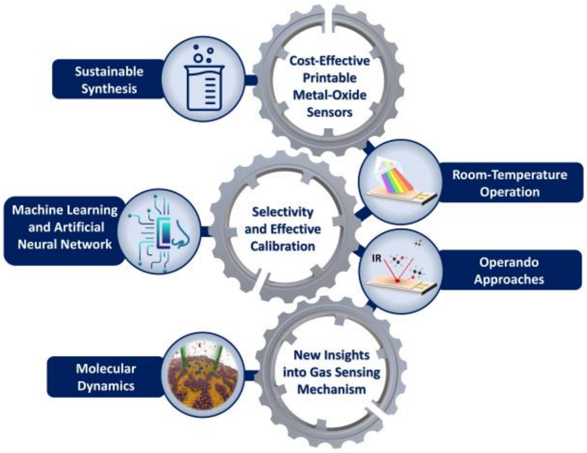


Figure 1. Overview of challenges and addressed cutting-edge strategies for printable metal oxide-based gas sensors [1].

The combination of unsuited sensitivity and selectivity restricts the range of gas detection and the sensor calibration linearity. Among the difficult gases to detect, CO_2 and oxygen are the most critical, since CO_2 has been inert for detection by MOXs, while elevated temperatures of exhausts require oxygen sensors working in a harsh environment.

Here, we provide multiscale strategy to address the challenges mentioned above (Figure 1) [1].

(i) Sustainable solutions aimed to lower long-standing MOXs power consumption and to enhance sensitivity by cost-effective materials: the use of visible light to activate gas sensitivity in MOXs combined with sustainable doping with alkali metals [2].
(ii) New mechanistic studies leading to overcome lack of selectivity and to accomplish a feasible calibration: machine learning and artificial neural networks as pioneering data-processing approaches to improve selectivity and to compensate for signal drift and non-linear sensitivity.
(iii) Advanced theoretical and experimental techniques to provide new insights into gas sensing mechanisms: chemisorption analyses and simulations by molecular dynamics would be valuable tools to support experimental *operando* investigations, e.g. DRIFT spectroscopy [3], studying the dynamics of physical/chemical adsorption of gaseous molecules on metal-oxide surface.

References

1. Pecunia,V., Petti, L., Andrews, J.B., Ollearo, R., *et al*., (2024) Roadmap on printable electronic materials for next-generation sensors. *Nano Futures* 8, 032001.
2. Rossi, A., Fabbri, B., Spagnoli, E., Gaiardo, A., *et al*., (2023) Functionalization of Indium Oxide for Empowered Detection of CO_2 over an Extra-Wide Range of Concentrations. ACS *Applied Materials & Interfaces*, 15, 28, 33732–33743.
3. Valt, M., Della Ciana, M., Fabbri, B., Sali, D., Gaiardo, A., Guidi, V., (2021) Design and validation of a novel operando spectroscopy reaction chamber for chemoresistive gas sensors. *Sensors and Actuators: B. Chemical* 341, 130012.

Qin Wang

Biography

Qin Wang received her Ph.D. degree in solid state physics at Lund University, Sweden in 1999. Now she is a senior expert at RISE and an adjunct professor at KTH. She is IEEE AVP of Women in Photonics, 2024 to 2026 (AVP stands for Photonics Society's Associate Vice President), also a member of IEEE Diversity Oversight Committee.

She is working on nanostructure-based electronics and photonics devices for sensing, imaging, communication, power electronics and life-science applications. She has experience working with EU projects from FP5 to EU H2020. She is the author or co-author of more than 100 international journal, conference and workshop papers, and a reviewer for international journals in photonics, sensors and micro/nano technology related areas. She has been engaged as expert reviewer to evaluate proposals for different calls from European Commission and as international/external reviewer of NSERC (Canada). She is supervisor for Master and PhD degree students, has been frequently invited to the assessment committee for PhD dissertation.

Graphene and Graphene-based Hybrids for Bio/Chemical and Industrial Sensing Applications

Qin Wang[1*], Olof Oberg[1], Simon Watanabe[1], Ingemar Petermann[1], Edoardo Trabaldo[2], Tom Yager[3], Anatolijs Sarakovskis[3]

[1]Research Institutes of Sweden (RISE), Stockholm, Sweden
[2]Research Institutes of Sweden (RISE), Gothenburg, Sweden
[3]Institute of Solid-State Physics (ISSP), Riga, Latvia

Email: *qin.wang@ri.se*[*]

Keywords: sensors, graphene, nano/micro fabrications

Sensors are widely used in our daily life, and further development and improvement of current sensing technologies are continually demanded. They are driven by applications and markets in various areas including health, wellbeing, green energy, sustainable cities, as well as promotion of industry innovation and infrastructure worldwide. As an atomically thick monolayer with remarkable optoelectronic tunability, graphene and its derived materials have shown unique potential as a tunable platform to enable new functionalities of various desired sensors.

This talk presents an overview of the graphene-based R&D work at RISE with a focus upon sensing applications. Two sensor examples will be highlighted. One is based on the integration of graphene with asymmetric metal meta-surfaces as shown in Figure 1 to sense CO_2 and/or alcohol in IR regimes [1-2]. The work was carried out by the collaborations with the Institute of Solid-State Physics (ISSP), Latvia, in the frame of the EU CAMART[2] project [3]. The results revealed the promise to enable simple and ultimate minimization sensing solutions for environmental monitoring, threat detection, and point of care diagnostics.

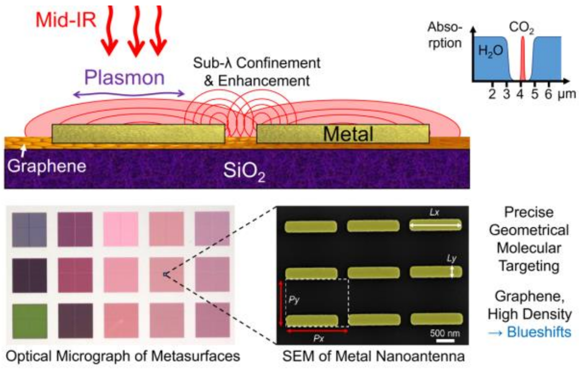


Figure 1. The sensor concept illustration of graphene with hybrid metal meta-surfaces.

Another highlight is the development of graphene-based THz detectors for sensing of illicit material for postal services and express courier flows within our ongoing EU project IFLOWS [4]. It aims to enhance detection capabilities of dangerous and illicit goods transported within post and parcels flows in EU.

References

1. Yager, T., Chikvaidze, G., Wang, Q., Fu, Y., (2023) Graphene Hybrid Metasurfaces for Mid-Infrared Molecular Sensors. *Nanomaterials* 13, 2113.
2. Fu, Y., Yager, T., Chikvaidze, G., Iyer, S., Wang, Q., (2021) Time-Resolved FDTD and Experimental FTIR Study of Gold Micropatch Arrays for Wavelength-Selective Mid-Infrared Optical Coupling. *Sensors* 21(15), 5203.
3. https://www.camart2.com/
4. https://www.ri.se/en/what-we-do/projects/detection-of-illicit-material-for-postal-services-and-courier-flows

Maria Rosaria Plutino

Biography

Maria Rosaria Plutino obtained her Ph.D. in Chemistry in 1997 at University of Messina, Italy. She is a Senior researcher at the Institute for the Study of Nanostructured Materials of the Italian National Research Council (ISMN-CNR) in Palermo, Italy. Her current research interests include essentially the design, the development and the structural study of innovative multi-component and multifunctional, organic, inorganic and hybrid nanostructured materials and composites, featuring implemented chemical-physical and mechanical surface properties, and useful for potential sustainable applications in different sectors such as building, blue-growth, textiles, environment, cultural heritage, biomedicine, sensors, catalysis. Recently, Dr. Plutino has set-up green and eco-friendly synthesis protocols starting from natural substances or waste, which lead to the obtainment of functional recyclable and re-usable materials. Dr Plutino is also co-founder, ex-President and Scientific manager of ATHENA Green Solutions S.r.l., an Innovative Start-Up, and Joint and not attended Spin-off by the CNR and by the Univ. of Messina. The basis of the Innovative Start-up is the Arginare entrepreneurial/patent idea. In particular, mission and objectives of the company are to research and produce systems and/or prototypes for the resolution of problems deriving from high environmental impact activities with particular reference to marine/coastal, industrial and urban pollution.

Smart and innovative multifunctional materials: from design and synthesis to sustainable applications

Maria Rosaria Plutino[1*]

[1]*Institute for the Study of Nanostructured Materials, ISMN – CNR, URT Messina, c/o Dep. ChiBioFarAm, Viale F. Stagno d'Alcontres 31, Vill. S. Agata, 98166 Messina, Italy*

Email: *mariarosaria.plutino@cnr.it*[*]

Keywords: smart materials, multifunctional hybrids, nanomaterials

Nowadays, nanotechnologies have shifted toward the development of hybrid nanomaterials and functional nanocomposites, which are distinguished by the presence of functional nanometric components or nanofillers dispersed in a polymeric matrix, resulting in improved properties over their starting components. The original concept is to create an enhanced nanohybrid or nanocomposite material that is suitable for surface coatings or other sustainable applications due to increased properties such as: 1) antifouling or antibacterial; 2) flame retardant; 3) drug release; 4) sensing; 5) mechanical resistance; and 6) pollutant absorption and degradation [1]. In particular, incorporating sensing functions into fabric textiles is a powerful approach toward the development of so-called "smart textiles," allowing for the development of wearable sensors, i.e., novel systems characterized by main textile characteristics such as flexibility, biocompatibility, comfort, and mechanical resistance, capable of reacting and adapting to specific external stimuli from their surroundings [2].

This work will show in detail the design, synthesis, and characterization of hybrid organic-inorganic materials (HOIM) and multifunctional, innovative, and smart nanocomposites based on functional nanostructured compounds in combination with sol-gel or blended polymeric 3D-matrices and/or with suitable dopants, used as-is or as coatings of various substrates, for uses in optoelectronic devices, sensors, catalytic processes, cultural heritage, environmental remediation, construction, blue growth, biomedicine.

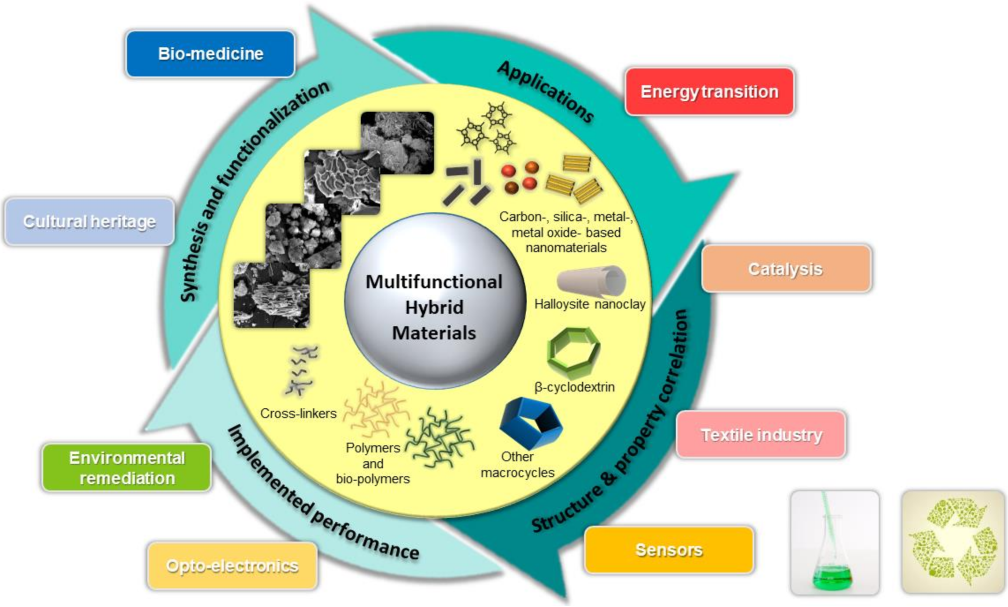


Figure 1. Overview of structure and property correlation, implemented performance, synthesis and functionalization, and applications of multifunctional hybrid materials.

The establishment of completely green and environmentally friendly synthesis techniques based on natural components or wastes to make functioning products that can also be recycled will be highlighted as a critical step toward sustainability.

References

1. Rando, G., Sfameni, S., Milone, M., Mezzi, A., Brucale, M., Notti, A., Plutino, M.R., (2024) Smart pillar[5]arene-based PDMAEMA/PES beads for selective dye pollutants removal: design, synthesis, chemical-physical characterization, and adsorption kinetic studies. *ChemSusChem*, 17(10), e202301502 and refs therein.
2. Rando, G., Sfameni, S., Hadhri, M., Mezzi, A., *et. al*., (2024) Methyl Red-loaded halloysite nanotubes-based silica coatings for durable dyeing of polyester fabrics. *Surfaces and Interfaces* 53, 105006 and refs therein.

Domenico Caputo

Biography

Domenico Caputo (Member, IEEE) is an Associate Professor with the Department of Information Engineering, Electronics and Telecommunications, University of Rome. He is a referee of several scientific journals, author of more than 200 articles in international journals and proceedings of international conferences, and principal investigator of several national and international projects. His main research fields concerned the development of amorphous silicon photodetectors for the detection of radiation from the UV to the near infrared range and of innovative electronic devices based on amorphous silicon. The present research interests include the development of thin-film photodetector and lab-on-chip system for DNA amplification and mycotoxin detection.

Thin and thick film technologies for smart and eco-friendly sensors and systems

Domenico Caputo[1*], Nicola Lovecchio[1], Francesca Costantini[2], Augusto Nascetti[3], Silvia Casalinuovo[1], Donatella Puglisi[4], Giampiero de Cesare[1]

[1]*Department of Information Engineering, Electronics and Telecommunications, University of Rome "La Sapienza", Rome, Italy*
[2]*Department of Environmental Biology, University of Rome "La Sapienza", Rome, Italy*
[3]*School of Aerospace Engineering, University of Rome "La Sapienza", Rome, Italy*
[4]*Department of Physics, Chemistry and Biology (IFM), Linköping University, Sweden*

Email: *domenico.caputo@uniroma1.it*[*]

Keywords: thin film sensors, lab-on-chip, amorphous silicon devices, sensors on textiles

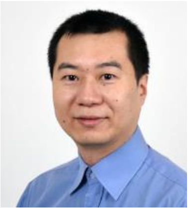
The talk focuses on the use of thin (below 1 μm) and thick (above few microns) film technologies for development of portable lab-on-chip (LoC) systems and of nanoparticles-based sensors deposited on cotton for volatile organic compounds detection.
LoC technology has gained great interest due to the many possibilities that it offers in the fields of genomics, medical diagnostics, and agriculture. Formerly, lab-on-chip devices essentially consisted of a microfluidic network that miniaturized the analytical and biochemical procedures leading to faster reaction kinetics and lower sample and reagents consumption. Recent devices integrate several functional modules, that allow all the functions of a human-scale test laboratory including transferring samples, drawing off a precise volume of a chemical product, reagent mixing, DNA extraction, detection, and quantification of biomolecules. Our group has developed a compact and portable lab-on-chip, where thin film sensors and actuators are combined in a multifunctional optoelectronic platform [1]. In particular, the platform integrates amorphous silicon sensors for on-chip detection and temperature control and optical filters for selection of specified wavelength. This platform has been coupled with different microfluidic networks and has been proved to be able to detect ochratoxin A down to 1.56 ppb [2], analytical sensitivity of 10^{-6} in analysing tenfold dilutions of RNA solutions for extracted watermelon and Sars-Cov 2 viruses and 100% of analytical specificity in testing different non target plant viruses [3].
The second part of this talk is focused on the preliminary development of an eco-friendly sensor deposited on cotton for detection of volatile organic compounds (VOCs), with the purpose of

serving as diagnostic tool in smart medicine applications [4]. Cotton functionalization and embroidery techniques for conductive patterning paved the way for the development of the mentioned smart textiles. They are based on gold nanoparticles (AuNP) and carbon nanotubes (CNT) to create a lock-and-key system between the target molecules and the sensing layer, whose interaction determines a change of electrical impedance and allow VOC concentration to be traced. The sensor has been exposed to different VOCs (ethanol, acetone, and ammonia) at different solution concentration and the impedance variation has been monitored in the 1 Hz - 1 MHz frequency range. Even though a detailed campaign needs to be carried out, the results demonstrate the possibility to discriminate the effect of different VOCs on the sensor response and to achieve calibration curves.

References

1. Lovecchio, N., Costantini, F., Nascetti, A., de Cesare, G., Caputo, D., (2022) Thin-Film-Based Multifunctional System for Optical Detection and Thermal Treatment of Biological Samples. *Biosensors* 12(11), 969,
2. Costantini, F., Lovecchio, N., Ruggi, A., Manetti, C., Nascetti, A., Reverberi, M., de Cesare, G., Caputo, D., (2019) A Fluorescent Label-Free Aptasensor Integrated in a Lab-on-Chip System for the Detection of Ochratoxin A in Beer and Wheat. *ACS Applied Bio Materials* 2(12), 5880-5887.
3. Costantini, F., Lovecchio, N., Nandimandalam, M., Manglli, A., Faggioli, F., Biasin, M., Manetti, C., Roversi, F.P., Nascetti, A., de Cesare, G., Caputo, D., (2023) Biomolecular Monitoring Tool Based on Lab-on-Chip for Virus Detection. *Biosensors* 13(5), 544.
4. Casalinuovo, S., Caschera, D., Quaranta, S., Genova, V., Buzzin, A., Federici, F., de Cesare, G., Puglisi, D., Caputo, D., (2023) Gold Nanoparticles-Functionalized Cotton as Promising Flexible and Green Substrate for Impedometric VOC Detection. *Materials* 16(17), 5826.

Yang Liu



Biography
Yang Liu is currently a tenured Senior Associate Professor with the Department of Management and Engineering, Linköping University, Sweden and an Adjunct Professor with the Industrial Engineering and Management, University of Oulu, Finland. He has been an Adjunct/Visiting Professor at multiple other universities. His research interests include sustainable smart manufacturing, product service innovation, decision support system, competitive advantage, control systems, autonomous robots, signal processing, and pattern recognition. Prof. Liu has authored or co-authored over 130 Web of Science publications. He is ranked No.1 among the top authors on "big data analytics in manufacturing" and "Industry 4.0-driven operations and supply chains for the circular economy", and among the top 1% of scientists in Engineering and Technology as well as Stanford-Elsevier list of the world's top 2% scientists. His publications have appeared in multiple distinguished journals, and some ranked in the top 0.1% ESI Hot Papers and the top 1% ESI Highly Cited Papers. He serves as Editor-in-Chief of Cleaner Engineering and Technology, Associate Editor of the prestigious Journal of Cleaner Production and Journal of Intelligent Manufacturing, and Editor or Guest Editor in several other renowned journals. He also serves as a reviewer in over 80 Web of Science journals.

Sustainable smart manufacturing: Current reality and future prospects

Yang Liu[1*]

[1]*Department of Management and Engineering, Linköping University, Linköping, Sweden*

Email: *yang.liu@liu.se*[*]

Keywords: sustainable smart manufacturing, lifecycle big data, emerging technologies

Innovations in smart technologies, such as the Internet of Things, Cyber-Physical Systems, Cloud Computing, Artificial Intelligence, Big Data Analytics, Digital Twin, etc., have enabled the progress of smart manufacturing. There is a lot of existing research on smart manufacturing and sustainable manufacturing. However, some problems are difficult but have not been adequately addressed so far. Sustainable smart manufacturing aims to integrate and apply various smart technologies in the entire lifecycle and decision-making processes, discover the real potential of lifecycle big data, achieve data and knowledge sharing among all lifecycle stages, and support the achievement of sustainable smart manufacturing in a lifecycle perspective. The work provides a comprehensive system view of sustainable solutions, especially in production and operations management, and emerging technologies in digitalization and modelling to create a new paradigm of sustainable smart manufacturing in a broader range of product lifecycles. The current state of the art and challenges are examined, and future research directions are suggested.

Olof Kordina

Biography

Olof got his master and licentiate degree from Lund University in solid-state physics and fascinated by the crystal growth processes, he moved to LiU in 1988 where he finalized his PhD. Improving crystal growth processes of semiconductors and building companies has become his great interest and mission in life. Olof has worked for several large companies, but his main calling is as an entrepreneur with three successful companies founded in Sweden: SweGaN, TekSiC, and Xtal.works. Science and deep-tech have always been close at heart for Olof and he has accumulated well over 100 publications and over 40 patents. Some of his inventions include the hot-wall CVD reactor for SiC which is used everywhere in the world, the high temperature CVD (HTCVD) which was 20 years ahead of its time, and the chlorinated epitaxial growth of SiC. Xtal.works is Olof's latest venture which is a pure environmental deep-tech company where problems are seen as currency. He has developed an unconventional approach to deep-tech entrepreneurialism where, according to him, KPIs like profits and revenues should be replaced by ideas, inventions, and collaborations. Unfortunately, this is not how VCs nor funding agencies see it…😂

Building bridges boosts businesses

Olof Kordina[1*], Karl-David Läpple[1], Nerijus Armakavicius[1], Vanya Darakchieva[1,2]

[1]Xtal.works Sweden AB, Forsa Säteri 2, 58391 Vikingstad, Sweden
[2] NanoLund, Lund University, Professorsgatan 1B, 22100 Lund, Sweden

Email: *Olof.kordina@xtal.works*[*]

Keywords: three city problem, silicon carbide, SiC, Fiammetta

The Christian writer Tertullian asked: What does Athens have to do with Jerusalem? [1] "Athens", representing science, philosophy, and reason was at the time seen as a threat to Christianity. Over the years, Tertullian's conundrum has gradually been settled and a working relationship between "Athens" and "Jerusalem" has been established, however, Luke Burgis argues that had Tertullian lived today he would add one more city with the ascent of "Silicon Valley", representing greed [2].

"Silicon Valley" is taking a lot of space – too much space some may think, and it is not surprising because if you google "What is the objective of a business?" you receive the answer that the objective of any business is to make a profit. Naturally, in line with this definition, the KPIs of any business are related to profits and revenues. Yet these KPIs are shortsighted and damaging for deep-tech startups with little near-term hope of selling anything. KPIs such as: number of patents filed per year; number of TRL levels passed; knowledge increase of employees; or the Value Creation Rate (VCR) would be a lot more helpful for these companies. Though not recognized, these KPIs are forward looking (or long-term greedy) which inspires setting long-term plans. "Silicon Valley" must not be ignored, but it should be tempered. "Jerusalem" has cast off its "cloak of Christianity" and adopted a modern view characterized by soft endeavors that do not generate immediate profit: Employee care (fulfilment of dreams), training employees (lifelong learning – the goal is to make them better that yourself), helping the community, or solving environmental problems. Undeniably, “Jerusalem” is an inevitability to achieving a sustainable business, yet little is done in deep tech companies, incubators, and VCs to realize this. Instead, they cast eyes on “Silicon Valley” and cling to past millennium practices such as extreme compartmentalization, excessive confidentiality, and noncompetes aiming to hinder employees following their calling or to hinder collaborations. This is counter-productive as many of the societal problems today cannot easily be solved by one entity alone but require collaborative (bridge-building) efforts.

A softer, more humane approach is proposed by the entrepreneur Uno Alfredéen [3] who argues that you must treat your employees well and allow them to leave if they must and they will become ambassadors for your company at their new workplace. He also recommends businesses to adopt an “open window policy” arguing that some ideas may fly out, but this is well compensated by a wealth of ideas coming back from the collaborative effort.

Xtal.works is an environmental deep-tech company eager to collaborate and build bridges. We treat problems as currency and are working on solving the problem of growing large diameter silicon carbide (SiC) crystals. Silicon carbide is advantageous to use in high-power applications on account of the huge energy savings. Replacing Si with SiC in an EV saves 7% of energy without tapping into the full potential of SiC’s abilities. Silicon carbide is also enabling fast chargers which is another anxiety for the environmentally conscious vehicle buyer. However, the current manufacturing technique, Physical Vapor Transport (PVT) cannot keep up with the demand and there is a need for a different manufacturing technique. This consequently prompted us to develop a technique we call Fiammetta, that surpasses the PVT technique in every aspect: production rate, cost, quality, energy consumption, and use of raw materials. The energy consumption and cost are for instance 50 and 10 times lower, respectively. The method is versatile; we saw that that a modification of the Fiammetta method can be used to generate Fermi level engineered quantum grade material needed for the quantum computer scientists searching for qubits in SiC.

References

1. Tertullian, The Prescription Against Heretics.
2. https://read.lukeburgis.com/p/reflections-on-the-three-city-problem
3. Alfredéen, U., Malmström, L., Burman, J., (2001) Konsten att bygga framgångsrika företag: praktika för entreprenörer, ISBN: 9789163117473.

Embassy of Italy
Stockholm

LINKÖPING
UNIVERSITY