



International Symposium on Olfaction and Electronic Nose  
Aveiro, Portugal, May 29 - June 1, 2022



# ISOEN 2022 CONFERENCE PROGRAM

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## Welcome Message



Dear ISOEN 2022 Participants: Welcome to Aveiro, Portugal!

On behalf of the Organizing Committee, it is our great pleasure to welcome you to beautiful town of Aveiro. After a hiatus due to the COVID-19 pandemics, ISOEN returns as in person meeting to Europe, to the Atlantic coast of Portugal.

ISOEN brings together experts in various fields of engineering, from biomedical to environmental to materials engineering to the artificial intelligence community, from all over the world, to discuss and exchange knowledge on how to build the next generation of electronic instruments for machine olfaction and gustation, either mimicking nature or introducing novel sensing concepts.

Following meetings in 2017 in Montreal and in 2019 in Fukuoka, ISOEN 2022 is also co-sponsored by ISOCs and IEEE Sensor Council, and most of the presented accepted papers will be published in the conference proceedings in IEEE Xplore, which enables many researchers to access them anytime and anywhere.

We have received 119 submissions that were reviewed with the aid of external reviewers and a member of the Technical Program Committee (TPC) to ensure the highest quality. The review process was double-blind and identical for all submissions. As a result, 98 papers were accepted for presentation (82% rate), 46 and 52 of which were assigned as oral papers and posters, respectively. Accepted papers came from 25 different countries from Asia/Pacific (30%), Europe (64%), North/South America (3%), and Africa and Middle East (3%). There were submissions 13 late news which were accepted as posters.

ISOEN 2022 will include a total of 11 oral sessions including two special sessions and poster sessions. These sessions cover topics of wide range: chemical sensors (gas, biosensors, ion-selective, optical), odor sampling (headspace analysis, dynamic sampling, pre-concentration and storage), sensor systems (electronic noses, electronic tongues, IoT), data analysis (signal processing, pattern recognition, chemometrics, AI, deep learning), applications (quality control, food safety, medical diagnostics, environmental monitoring), robotic system (robots with chemical senses, drone) and bioengineering (cell-based olfactory sensors, receptor-based sensors).

Three keynotes will be made by Prof. Krishna Persaud (Manchester University, UK) on proteins for bioelectronic noses, Prof. Hossam Haick (Technion, Israel) on health monitoring sensor applications and by Prof. Manel del Valle (Autonomous University of Barcelona, Spain) on electronic tongue applications to illicit drug detection. Two special sessions will be dedicated to biomimetic biosensors and bioelectronic noses, and electronic noses and tongues for healthcare applications.

The tutorial session on Sunday, May 29 is composed of two blocks: dedicated to the electronic tongues, which include lectures on Voltammetric electronic tongues, Chemical sensors for e-tongue applications and Microelectronics-based multi-sensor systems, and dedicated to the electronic noses application to air quality analysis, which includes lectures on Environmental odour monitoring: Sensorial techniques vs. artificial olfaction: current status and future perspectives, Field calibration and beyond for air quality multisensor systems and Low cost sensors and data analysis for indoor air quality monitoring.

ISOEN 2022 would not have been possible without help and support of the ISOCs and IEEE community and we would like specifically acknowledge James Covington, ISOCs president,

Santiago Marco, Program Committee Chair, Jan Mitrovics, conference treasurer, Deepak Uttamchandani, IEEE Sensor Council president elect, Saverio de Vito, Tutorials Chair, Krishna Persaud, Plenaries Chair, Patrick Miele, ISOCS secretary, all the members of the Organization and Program Committees, and all the volunteers who contributed to the peer-review process.

We would like to give sincere thanks to the professional conference organizers, Conference Catalysts, LLC and Epapers, with special thanks to Caroline Kravec and Tom Wehner, for their support of paper submission and publishing process.

And of course, we would like to acknowledge all the speakers, participants, and authors who contributed to this conference and to the published proceedings.



Alisa Rudnitskaya,

General Chair ISOEN 2022

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## Tutorials



### **Voltammetric Electronic Tongues: Sensors, Materials and Applications**

**Instructor:** Manel del Valle, *Autonomous University of Barcelona, Spain*

**Date:** Sunday, May 29<sup>th</sup>

**Time:** 9:30 – 10:30

**Small Auditorium, 1st floor**

**Abstract:** This tutorial will present an introduction to electronic tongue analysis systems, which are those that employ voltammetric sensors as chemical information providers. In it, an overview of the

different variants proposed so far is offered, both in terms of the nature of the sensors used, and the materials that can be employed. Special mention will be given to bioelectronic tongues, that is, when one or several biosensors are incorporated into the sensor array. In particular, given the larger dimensionality occurring when voltammetric sensors are used, some strategies that may be used will be presented. Finally, some relevant examples of application, in qualitative identifications or in quantitative determinations will be illustrated.

**Bio:** Dr. Manel del Valle is full professor of Analytical Chemistry at the Chemistry Department of the Autonomous University of Barcelona (UAB, Spain). He received his Ph.D. degree from the UAB in 1992. He has been an active member of the Sensors & Biosensors Group at the UAB since its founding. He has wide experience in teaching and research in analytical chemistry, and, particularly, on the different sensor and biosensor families, automatic analysis systems and computer-based instrumentation. He has undertaken post-doctoral studies in Porto (Portugal), Newcastle (UK), Graz (Austria) and Mexico. His present research lines comprise electrochemical sensors and design and optimization of automated analytical systems. He initiated at the UAB the research lines of sensor arrays and electronic tongues and the use of Electrochemical Impedance Spectroscopy for the development of chemical sensors and biosensors. With the latter he has made important contributions in the topic of impedimetric genosensors and aptasensors. He is the author of more than 200 publications in indexed international journals, 35 book chapters, and he has supervised or co-supervised 21 doctoral theses.



## Tutorials Continued



### **Chemical Sensors for e-tongue Applications: Working Principles, Advantages and Drawbacks**

**Instructor:** Larisa Lvova, *University of Rome Tor Vergata, Italy*

**Date:** Sunday, May 29<sup>th</sup>

**Time:** 10:50 – 11:50

**Small Auditorium, 1st floor**

**Abstract:** The main types of chemical sensors employed in the modern e-tongue systems will be represented. Particular attention will be given to the

overview of the working principles and concrete applications of electrochemical, optical, mass-sensitive and multi-transduction sensor arrays for qualitative and quantitative analysis of complex liquid samples. The advantages and drawbacks of different sensors types for e-tongue applications will be discussed, and the concrete applications will be illustrated.

**Bio:** L. Lvova received her M.S. (1996), Ph.D. (1999) degrees in physical chemistry and Dr.Sc. (2017) degree in Analytical Chemistry from St. Petersburg State University, Russia, and Ph.D. (2012) in Chemical Sciences from “Tor Vergata” University, Rome, Italy. As a Postdoctoral Fellow, L. Lvova worked in the Chemical Sensors Research Group at the Chemistry Department of Kwangwoon University, Seoul, South Korea (2000-2001). From November 2019 L. Lvova is Assistant Professor at the Department of Chemical Science and Technology of “Tor Vergata” University, Rome, Italy. L. Lvova research work is concerned with the design, synthesis, and characterization of novel sensing materials for chemical sensors, both electrochemical and optical, and their application for qualitative and quantitative analysis of complex liquid media. The elaboration of the new analytical procedures and sensitive materials with different transduction principles for application in multisensory systems mimicking artificial olfaction and taste systems, electronic nose and electronic tongue in particular, implementation of chemometric methods of data analysis for artificial sensing systems output elaboration, and applications of such multisensory systems for ecological monitoring, industrial processes control, beverages and foodstuff analysis, clinical analysis, etc, represent main areas of Dr. Lvova scientific interest.

## Tutorials Continued



### Artificial Intelligence Techniques for the Electronic Tongue Data Processing

**Instructor:** Luca Gerevini, *University of Cassino and Southern Lazio, Italy*

**Date:** Sunday, May 29<sup>th</sup>

**Time:** 11:50 – 12:50

**Small Auditorium, 1st floor**

**Abstract:** Nowadays, the problem of pollution in water is a very serious issue to be faced and it is crucial to monitor it with non-invasive and low-cost solutions, like those offered by electronic tongue technologies. In this tutorial I'll show the most common data processing techniques connected with the electronic tongue technologies, putting the focus on the major advantages and disadvantages. Throughout all the tutorial I'll present the solutions and the techniques used by our smart system developed to detect and classify pollutants spilled into wastewater and based on the Sensichips electronic tongue called Smart Cable Water.

**Bio:** Luca Gerevini got master's degree in 2019 in Computer Engineering at the University of Cassino and Southern Latium, Cassino, Italy. From 2019 to 2021 worked as Software Engineer in the Research and Development Area of Sensichips s.r.l company. Since later 2021 is working as Software Engineer in the Research and Development Area of E-Lectra s.r.l company. From 2019 he has been a PhD. Student at University of Cassino and Southern Latium, Cassino, Italy, where his main interest is focused on the application of artificial intelligence techniques for the detection of pollutants in the air and water, oriented to the IoT paradigm. Others interest concern the application of machine learning techniques for the estimation of batteries State of Health and State of Charge. (e-mail: [luca.gerevini@unicas.it](mailto:luca.gerevini@unicas.it)) – University of Cassino and Southern Lazio (Italy).

## Tutorials Continued



### **Environmental Odour Monitoring. Sensorial Techniques Vs. Artificial Olfaction: Current Status and Future Perspectives**

**Instructor:** Laura Capelli, *Politecnico di Milano, Italy*

**Date:** Sunday, May 29<sup>th</sup>

**Time:** 14:00 – 15:00

**Small Auditorium, 1st floor**

**Abstract:** Odour pollution is nowadays considered as a serious environmental concern: odour nuisance is one of the most frequent causes of complaints from the citizens to the Local Authorities. As a consequence, odour emissions are currently subject

to control and regulation in many countries. Despite this growing attention towards odour pollution, the possibility of measuring odours is still regarded more as an art than a science. However, specific techniques have been developed over the years with the specific objective to quantify odour emissions and determine their impact on communities. Historically, odour characterization was based on the analytical determination of the chemical composition of odorous mixtures. Over the years, sensorial techniques, relying on the use of the human nose as a sensor, have become more and more popular, and are currently the reference method for odour measurement in most countries worldwide. In this context, the application of artificial olfaction for environmental monitoring purposes is considered as extremely interesting, because of its potential to overcome some of the most critical limitations related to sensorial techniques. This tutorial aims to provide an overview on the problem of odour pollution, and illustrate the current techniques for odour measurement and odour impact assessment. In this context, particular attention will be given to the illustration of the emerging role that artificial olfaction is gaining in this field, thereby focusing on the potentialities and limitations of so-called Instrumental Odour Monitoring Systems (IOMS), and thus making some considerations on future perspectives of environmental air quality applications.

**Bio:** Laura Capelli is Associate Professor at Politecnico di Milano, Department of Chemistry, Materials and Chemical Engineering “Giulio Natta”. At the Olfactometric Laboratory her activity focuses on different aspects of chemical engineering, specializing in odour measurement and control issues.

Her main research activity is related to the study and the development of sensor systems (“electronic noses”), especially for environmental odour monitoring, which was the topic of her PhD, and determined a unique expertise in the development of electronic noses and their applications in different fields.

Indeed, recently, the development of electronic noses combined with specific machine learning tools has expanded to include applications in the food and biomedical sectors, and process control.

In particular, over the last 5 years, a significant part of her research activity focused, thanks to an important collaboration with Humanitas Research Hospital, on the development of an electronic nose for the early and non-invasive detection of prostate cancer. This activity led to important clinical and scientific achievements, as well as awards (1st Prize “Disruptive Innovation” within the Switch-2-Product Innovation Challenge promoted by Politecnico di Milano, PoliHub and Deloitte). In 2021, the project obtained a PoC investment of 200 k€ from a Venture Capital fund with the aim of increasing the TRL and found a start-up.

Moreover, she is also involved in research activities aiming to the development and combination of atmospheric dispersion models with other monitoring techniques, by means of suitable multivariate statistical approaches and micrometeorological methods.

The experience gathered in the field of odour analysis led to the appointment as scientific manager of a H2020 project regarding the development of innovative approaches for the monitoring of odour nuisances.

The research activity led to the publication of more than 170 papers in journals, books and conferences (>100 ISI/Scopus indexed publications; Scopus H-Index = 23). She is scientific coordinator and organizer of the NOSE international conference series on environmental odour monitoring and control, and member of the scientific committee of other relevant conferences in this field (e.g., ISOEN, IWA, MKO)

## Tutorials Continued



### Field Calibration and Beyond for Air Quality Multisensors Systems

**Instructor:** Saverio de Vito, *ENEA, Italy*

**Date:** Sunday, May 29<sup>th</sup>

**Time:** 15:00 – 16:00

**Small Auditorium, 1st floor**

**Abstract:** Filed calibration use field recorded data to build calibration models for low cost air quality sensors. It is the current gold standard for allowing sufficient accuracy in estimating pollutant concentrations, addressing the well known low cost

chemical sensors limitations in terms of fabrication variance, sensitivity and selectivity. Actually, this data driven AI approaches have shown their success in a number of reports with operative field deployment lasting several months. Despite its operational success, filed calibration is a considerably costly procedure, requiring mid term colocation with reference equipments, and it is still affected by concept and sensor drift issues which challenge its robustness to relocation or seasonal changes. Emerging methodologies like global and adaptive, network (remote) calibration promise to reduce the needed efforts at a reduced performance cost. This tutorial will introduce field calibration methodologies addressing its limitations through real life, operational, examples while presenting the new insights from literature which promise to go beyond them towards truly integrated hierarchical AQ monitoring networks.

**Bio:** Saverio De Vito holds a Ph.D. in Information Engineering. Formerly a SW architect specializing in TLC/EO satellite platforms and their applications, since 2004 He is a senior researcher and team leader with ENEA. His research focuses on artificial olfaction, smart cyber physical systems & IoT, intelligent sensing and machine learning with application to environmental (air quality) monitoring, energy, aerospace industry, water management cycle. He pioneered Citizen Science approaches to Air Quality monitoring, field calibration methodologies for low cost AQ sensors, and distributed sensing for water infrastructure which have been subject of several patents. He coordinated/participated in several international research projects funded by FP7, H2020, FLAG-ERA, CLEANSKY, and UIA programs. He co-authored more than 90 scientific contributions in Journals and Conferences. He is Educational Chair of ISOCS and is an IEEE, ETIP-PV, AISEM Member. He serves in UNI GL4 group as well as IEEE P2520.1 standardization working group for odour and olfactive nuisance monitoring. He is a member of technical committee of ISOEN, IJCNN, Eurosenors and serves as a reviewer and guest editor for many journal in sensors, measurements, AI and environmental science fields. He has been professor of Computer engineering at University of Cassino since 2005 and for MAIA international master since 2015. He participated in several science communication actions targeting general public on national and international broadcasters. He was a member of 28th Italian research expedition in Antarctica.

## Tutorials Continued



### Low Cost Sensors and Data Analysis for Indoor Air Quality Monitoring

**Instructor:** Nathalie Redon, *IMT Lille Douai, France*

**Date:** Sunday, May 29<sup>th</sup>

**Time:** 16:20 – 17:20

**Small Auditorium, 1st floor**

**Abstract:** Indoor air is a recognized contributor to excess mortality and premature deaths. However, indoor air remains unregulated while outdoor air is submitted to standards and limits for pollutants such as nitrogen dioxide, ozone, or particles [2008/50/EU Directive for Europe or Clean Act with NAAQS standards for US]. Only few guidelines are proposed to avoid hazardous exposure [WHO, 2000]. However, indoor air pollutants are numerous, involving a wide variety of sources: building and furnitures (materials and surfaces), behaviour and activities of occupants (smoking, cleaning, cooking, aerosol, candles, etc.), including pollution brought from outdoor by natural or mechanical ventilation [W. Murad et al. 2011; Anses 2020; OQAI 2013]. Because of the need for framing, the complexity of the phenomena involved and a proven health impact, interest in this area has grown steadily in recent years. To monitor indoor air pollution with a high objective of data quality, reference analyzers and equivalent methods are typically used and described in different relevant standards. These approaches rely on expensive instruments with complex maintenance. They are too invasive for confined environments, energy-intensive, and ultimately provide only poor spatial and temporal report of the pollutants of interest. To satisfy the need for real time indoor air quality (IAQ) monitoring, multi-sensor systems developed widely through: micro-electronic technology, spread of wireless systems and data management [E. G. Snyder et al. 2019]. Such IAQ sensor systems allow building dense networks with small mesh sized to assess microenvironments [F. E. Ahangar et al. 2019].

In this lecture, we first recall the nature, concentrations and sources of pollutants of interest in indoor environments. Among them, a focus is done on priority pollutants related to adverse health impacts. The European Respiratory Society (ERS) has identified VOCs, CO<sub>2</sub> and particulates as key contributors to indoor air pollution [Demanega et al., 2021]. This approach is questioned in connection with sensors developed for IAQ monitoring. An overview of studies implementing IAQ sensors highlights the strengths and limitations of such systems. To that end, different aspects are presented: metrological quality of data, especially for VOC detection, contribution of data-sciences, and connections with other fields of research and applications (social science, epidemiology, public policies, citizen exposure). Finally, current weaknesses and future paths to be explored are discussed.

**Bio:** Ph. D. in electronics, Nathalie Redon works at IMT Nord Europe as Assistant Professor in the Energy & Environment Research Centre. Her main topics deal

with sensors for air quality applications: i/development of air quality sensors based on conducting composites sensitive surfaces for the detection on different pollutants of interest at trace levels (ammonia, formaldehyde, hydrogen sulfide, etc.), ii/detection and quantification of specific gases or particles involved in indoor, ambient air or breath analyses, iii/advanced data treatment based on multi-sensor systems to assess signatures of pollution. She is a member of the LCSQA (Central Laboratory for Air Quality Monitoring) in France, in charge of the development and implementation of metrological evaluation protocols for micro- sensors dedicated to measurement of regulated or non-regulated pollutant. Concerning indoor air quality topic, her main current projects are dedicated to the development of mobile, autonomous and portable multi-sensor stations, able to quantify individual exposure to air pollutants (VEILLAIR & CERBAIR Project). Multi-sensor stations are also deployed to determine their impact in Individual Dwellings and Psycho-Sociological Analysis of Occupant Behavior (QOUSTO & QALIPSO project). She also contributes to the optimization of the intrinsic dimension of multi-sensor QA stations, to build a dynamic indicator of individual exposure (CAPTAIR & INDEX project) Academic and industrial collaborations: Universidade Technical de Sergipe (Brésil), Paris Sud University, Atmo Hauts-de-France, TVES Laboratory (Territoires, Villes, Environnement et Société) ULCO University, LADYSS Laboratory (Dynamiques sociales et recomposition des espaces) Paris University, CozyAir, Ellona (ex Rubix), TERA Group, etc. Funding: ADEME, CARNOT MINES, IReNE (Innovation Recherche en Environnement), Hauts-de-France Region, IMT Nord Europe, ANR, etc.

## Keynote Speakers



**Prof. Krishna Persaud**, *University of Manchester, Manchester, UK*

### **Tailoring Proteins for a Bioelectronic Nose**

**Date:** Monday, May 30<sup>th</sup>

**Time:** 9:20 – 10:20

**Small Auditorium, 1st floor**

**Abstract:** Biological materials have extraordinary powers of self-assembly and receptors and binding proteins have binding sites capable of interacting with large numbers of small molecules with varying levels of

specificity. Building on the combinatorial design of chemical sensing structures in living organisms it is now possible to utilise these biorecognition elements into transducers that can be used for electronic noses. As a result, sensing elements involved in olfaction in natural environments, such as Olfactory Receptors (ORs) or Odorant Binding Proteins (OBPs), are bringing great impetus to the development of electronic noses. In contrast to electronic noses that traditionally rely on chemical sensors with relatively poor selectivity, bio-electronic noses may benefit from the naturally optimized molecular affinities and intrinsic sensitivities of bioreceptors towards odorants. Individual receptors can bind different odorants with distinct affinities and specificities, therefore broadly selective arrays can be designed, and associated with multiparametric data analysis and pattern recognition algorithms. Developing artificial biosensor arrays brings several challenges, which include: (i) the selection and expression of wild type bioreceptors eventually combined with biomolecular engineering in order to design mutants that are tuned to reach optimum affinities with target odorants, (ii) the immobilization of the biosensing elements onto chemical transducers' surfaces while preserving the biological functionality of the probe, (iii) and finally the use of highly sensitive transducers with appropriate sensing interface to stabilize the sensitive layer. Here we show how an array of diverse odour sensors can be achieved for targeted applications.

**Bio:** Krishna Persaud, PhD, FRSC, FInstMC, graduated with BSc Hons Biochemistry at the University of Newcastle-upon-Tyne, UK in 1976, MSc in Molecular Enzymology at the University of Warwick, UK, in 1977 and a PhD specialising in olfactory biochemistry in 1980. He subsequently worked at the University of Newcastle-upon-Tyne, University of Pisa and the Medical College of Virginia extending his knowledge in the Chemical Senses. He is Professor of Chemoreception at the University of Manchester, Department of Chemical Engineering. In his career, he has carried out research in chemoreception, crossing disciplines from biological aspects of olfaction to sensor arrays, electronics, signal processing and pattern recognition, and commercial development of artificial olfaction technologies.



## Keynote Speakers Continued



**Prof. Hossam Haick, Technion – Israel  
Institute of Technology, Haifa, Israel**

### **Lifelong Sensors for Overall Health Monitoring and Prevention**

**Date:** Tuesday, May 31<sup>st</sup>

**Time:** 9:00 – 10:00

**Small Auditorium, 1st floor**

**Abstract:** Contemporary medicine suffers from many shortcomings in terms of successful disease diagnosis and treatment, both of which rely on detection capacity and timing. The lack of effective, reliable, and affordable detection and real-time monitoring limits the affordability of timely

diagnosis and treatment. A new frontier that overcomes these challenges relies on smart health monitoring systems that combine wearable sensors and an analytical modulus. The current talk presents recent advances from our team on smart biocompatible and self-healing materials for the development of multifunctional sensors and wearable devices for an overall health monitoring and prevention while providing a bird's eye-view of their characteristics, functions, and applications. The talk also shows how these wearables could be fitted with artificial intelligence (AI) to support systems for clinical decision in early detection, accurate diagnosis, and long-life monitoring of health disorders. The ongoing challenges and future prospects for providing personal healthcare with AI-assisted support systems relating to clinical decisions will be also presented and discussed.

**Bio:** Hossam Haick is a Full Professor in the Technion – Israel Institute of Technology and the Dean of Undergraduate Studies. He is an expert in the field of nanotechnology and non-invasive disease diagnosis. His studies include the research and development of nano-array devices for screening, diagnosis and monitoring of disease, nanomaterial-based chemical (flexible) sensors, electronic skin, breath analysis, volatile biomarkers, and cell-to-cell communication. His studies have generated more than 300 publications, with H-index ~76. The technologies developed by Prof. Haick and his team have led to the production of more than 52 patents and patent applications – many of which have been licensed to six international companies and ground for startup companies. Prof. Haick has received more than 82 prizes and recognitions, including the Knight of the Order of Academic Palms, the Humboldt Senior Research Award, the “Michael Bruno” award for scientists of truly exceptional, etc. He was also included in more than 42 important ranking lists, such as the of the world's 35 leading young scientists by MIT Magazine (2008), top-100 innovators in the world (2015-2018) by various international organizations, etc.

## Keynote Speakers Continued



**Prof. Manel del Valle**, *Universitat Autònoma de Barcelona, Barcelona, Spain*

### **Experiences in the Detection of Drugs of Abuse in Smuggling Seizures and Forensic Samples Using Electronic Tongue Principles**

**Date:** Wednesday, June 1<sup>st</sup>

**Time:** 9:00 – 10:00

**Small Auditorium, 1st floor**

**Abstract:** The application of voltammetric sensors to the analysis of illicit drugs in combination with different chemometric tools to achieve their identification and quantification is explored herein. The aim is to process the whole voltammograms obtained from different sensors as a unique profile, and analyze those with the aid of pattern recognition methods that allow the extraction of a characteristic fingerprint, rather than focusing on the oxidation peaks associated to each of the drugs. To this aim, different arrays of electrodes were prepared to analyze samples employing square wave voltammetry (SWV). Next, identification of different drugs was achieved by means of principal component analysis (PCA) and linear discriminant analysis (LDA), while their quantification was attained by partial least squares (PLS) modelling.

**Bio:** Dr. Manel del Valle is full professor of Analytical Chemistry at the Chemistry Department of the Autonomous University of Barcelona (UAB, Spain). He received his Ph.D. degree from the UAB in 1992. He has been an active member of the Sensors & Biosensors Group at the UAB since its founding. He has wide experience in teaching and research in analytical chemistry, and, particularly, on the different sensor and biosensor families, automatic analysis systems and computer-based instrumentation. He has undertaken post-doctoral studies in Porto (Portugal), Newcastle (UK), Graz (Austria) and Mexico. His present research lines comprise electrochemical sensors and design and optimization of automated analytical systems. He initiated at the UAB the research lines of sensor arrays and electronic tongues and the use of Electrochemical Impedance Spectroscopy for the development of chemical sensors and biosensors. With the latter he has made important contributions in the topic of impedimetric genosensors and aptasensors. He is the author of more than 200 publications in indexed international journals, 35 book chapters, and he has supervised or co-supervised 21 doctoral theses.

## **Awards**

### **Wolfgang Göpel Memorial Award**

The Wolfgang Göpel Memorial Award recognizes young researchers with a record of valuable contributions to the field.

### **Industrial Award**

The Best Industrial Presentation on the best application of an Electronic Nose or Electronic Tongue is rewarded by Alpha-MOS (France).

### **Best Paper Award**

Nomination for the Best Paper award will be done by the by the Technical Program Committee and made public in the Opening ceremony. The winner will be selected by the votes of the conference participants and appointed committee that will attend all the nominated presentations. Note: The Best Paper award is independent of the other Industrial and the Göpel Memorial Award.

## Technical Program: Sunday, 29 May 2022

*\*All times stated are local time of Aveiro, Portugal*

9:15 – 9:30

### **Registration**

Entrance Hall, ground floor

9:30 – 10:30

### **Tutorial: Voltammetric Electronic Tongues: Sensors, Materials and Applications**

Manel del Valle, *Autonomous University of Barcelona*

Small Auditorium, 1<sup>st</sup> floor

10:30 – 10:50

### **Coffee Break**

Foyer, 1<sup>st</sup> floor

10:50 – 11:50

### **Tutorial: Chemical Sensors for E-Tongue Applications: Working Principles, Advantages and Drawbacks**

Larisa Lvova, *University of Rome Tor Vergata*

Small Auditorium, 1<sup>st</sup> floor

11:50 – 12:50

### **Tutorial: Artificial Intelligence Techniques for the Electronic Tongue Data Processing**

Luca Gerevini, *University of Cassino and Southern Lazio*

Small Auditorium, 1<sup>st</sup> floor

12:50 – 14:00

### **Lunch**

Foyer, 2<sup>nd</sup> floor

14:00 – 15:00

### **Tutorial: Environmental Odour Monitoring. Sensorial Techniques Vs. Artificial Olfaction: Current Status and Future Perspectives**

Laura Capelli, *Politecnico di Milano, Italy*

Small Auditorium, 1<sup>st</sup> floor

15:00 – 16:00

### **Tutorial: Field Calibration and Beyond for Air Quality Multisensors Systems**

Saverio de Vito, *ENEA, Italy*

Small Auditorium, 1<sup>st</sup> floor

16:00 – 16:20

### **Coffee Break**

Foyer, 1<sup>st</sup> floor

16:20 – 17:20

### **Tutorial: Low Cost Sensors and Data Analysis for Indoor Air Quality Monitoring**

Nathalie Redon, *IMT Lille Douai, France*

Small Auditorium, 1<sup>st</sup> floor

## Technical Program: Sunday, 29 May 2022

18:00 - 22:00

**Conference Social Event**

Foyer, 2<sup>nd</sup> floor

## Technical Program: Monday, 30 May 2022

All times stated are local time of Aveiro, Portugal

8:30 – 9:00

### Registration

Entrance hall, ground floor

9:00 – 9:20

### Opening Ceremony

Small Auditorium, 1<sup>st</sup> floor

9:20 – 10:20

### Keynote: Tailoring Proteins for a Bioelectronic Nose

Krishna Persaud, *University of Manchester*

Small Auditorium, 1<sup>st</sup> floor

Session Chair: James Covington, *University of Warwick*

10:20 - 11:00

### Electronic Tongues 1

Small Auditorium, 1<sup>st</sup> floor

Session Chairs: Larisa Lvova, *University of Rome Tor Vergata*

Manel del Valle, *Universitat Autònoma de Barcelona*

10:20

### 8021 Impedimetric Bio-Electronic Tongue Based on Silver Nanoparticles for the Analysis of Milk

Clara Pérez-González, Coral Salvo-Comino, Jose Luis Pura, Fernando Martin-Pedrosa, Cristina García-Cabezón, María Luz Rodríguez-Méndez  
University of Valladolid, Spain

10:40

### 8043 A Reconfigurable Integrated Electronic Tongue and its Use in Accelerated Analysis of Juices and Wines

Gianmarco Gabrieli, Michal Muszynski, Patrick Ruch  
IBM Research, Switzerland

11:00 – 11:20

### Coffee Break

Foyer, 1<sup>st</sup> floor

11:20 - 12:20

### Electronic Tongues 1 cont.

Small Auditorium, 1<sup>st</sup> floor

Session Chairs: Larisa Lvova, *University of Rome Tor Vergata*

Manel del Valle, *Universitat Autònoma de Barcelona*

11:20

### 8083 Experiences in the Detection of Drugs of Abuse in Smuggling Seizures and Forensic Samples Using Electronic Tongue Principles

Xavier Cetó, Marta Bonet-San-Emeterio, Dionisia Ortiz-Aguayo, Elena Rodríguez-Franch, Manel Del Valle  
Universitat Autònoma de Barcelona, Spain

## Technical Program: Monday, 30 May 2022

11:40

### **8126 Impedimetric Electronic Tongue for the Detection of Marine Toxins**

Mariana Isabel C. Raposo{2}, Silvia Soreto{2}, Catarina Moreirinha{2}, Maria Teresa S.R. Gomes{2}, Maria João Botelho{1}, Luis Cadillon Costa{2}, Alisa Rudnitskaya{2}  
{1}IPMA, CIIMAR, University of Porto, Portugal; {2}University of Aveiro, Portugal

12:00

### **8039 Potentiometric e-Tongue for Anti-Inflammatory Pharmaceuticals Screening**

Sara Farotto{2}, Claudia Caltagirone Caltagirone{1}, Giacomo Picci{1}, Vito Lippolis{1}, Roberto Paolesse{2}, Corrado Di Natale{2}, Larisa Lvova{2}  
{1}Università degli Studi di Cagliari, Italy; {2}Università di Roma Tor Vergata, Italy

12:20 – 13:50

#### **Lunch**

Foyer, 2<sup>nd</sup> floor

13:50 - 15:10

#### **Electronic Noses 1**

Small Auditorium, 1<sup>st</sup> floor

Session Chair: Jordi Fonollosa, *Universitat Politècnica de Catalunya*

13:50

### **8116 Rapid Recognition of Olfactory Scenes with a Portable MOx Sensor System Using Hotplate Modulation**

Damien Drix, Nik Dennler, Michael Schmuker  
University of Hertfordshire, United Kingdom

14:10

### **8064 Identification of Gas Species and Their Concentrations by Using Sorption Kinetics of Viscoelastic Film**

Kosuke Minami, Kota Shiba, Gaku Imamura, Genki Yoshikawa  
National Institute for Materials Science, Japan

14:30

### **8052 A Movie Should Be Forever: Monitoring the Degradation Pathway of Photographic Films**

Lorena Di Zazzo{1}, Gabriele Magna{1}, Rosamaria Capuano{1}, Silvia Prati{2}, Giorgia Sciutto{2}, Marco Chavez Lozano Chavez Lozano{2}, Rocco Mazzeo{2}, Corrado Di Natale{1}, Roberto Paolesse{1}  
{1}Università di Roma Tor Vergata, Italy; {2}University of Bologna, Italy

14:50

### **8060 MOS Gas Sensors for Food Quality Monitoring Using GC-MS and Human Perception as Reference**

Julian Joppich, Oliver Brieger, Ksenia Karst, Daniel Becher, Christian Bur, Andreas Schütze  
Saarland University, Germany

15:10 – 15:30

#### **Coffee Break**

Foyer, 1<sup>st</sup> floor

## Technical Program: Monday, 30 May 2022

15:30 - 17:00

### Poster session - Electronic Noses 2

Small Auditorium, 1<sup>st</sup> floor

#### **8050 Odour Impact Assessment by Instrumental Odour Monitoring Systems: A Case Study Focusing on the Differentiation of Different Odour Sources and Performance Testing**

Beatrice Julia Lotesoriere, Carmen Bax, Laura Capelli  
Politecnico di Milano, Italy

#### **8022 Gas Source Localization Based on Binary Sensing with a UAV**

Thomas Wiedemann{1}, Monika Scheibe{1}, Marius Schaab{1}, Juan Marchal Gomez{1}, Dmitriy Shutin{1}, Achim J. Lilienthal{2}  
{1}German Aerospace Center, Germany; {2}Örebro University, Sweden

#### **8133 Towards Artificial Intelligent Olfactory Systems**

Gina Zeh{1}, Helen Haug{2}, Maximilian Koehne{3}, Satnam Singh{1}, Andreas Grasskamp{1}, Tilman Sauerwald{1}  
{1}Fraunhofer-Institute for Process Engineering and Packaging, Germany; {2}Friedrich-Alexander-University Erlangen-Nuremberg, Germany; {3}Saarland University, Germany

#### **8134 Design and Fabrication of Robust-Reliable Sensing Platform for Artificial Olfactory Systems**

Anjitha R G, Palash Kumar Basu  
Indian Institute of Space Science and Technology, India

#### **8139 A Portable Personalised Environmental Quality Monitoring System (PONG) Ver. 2**

James Covington, Joanne Nock  
University of Warwick, United Kingdom

#### **8142 Industrial Gases Identification Using Graphene-Based Gas Sensors: NH<sub>3</sub> and PH<sub>3</sub> as an Example**

Shirong Huang{1}, Alexander Croy{2}, Luis Antonio Panes-Ruiz{1}, Vyacheslav Khavrus{3}, Bergoi Ibarlucea{1}, Gianaurelio Cuniberti{1}  
{1}Dresden University of Technology, Germany; {2}Friedrich Schiller University Jena, Germany; {3}SmartNanotubes Technologies GmbH, Germany

#### **8143 Machine Learning-Enabled Biomimetic Electronic Olfaction Using Graphene Single-Channel Sensors**

Shirong Huang{1}, Alexander Croy{2}, Antonie Bierling{1}, Luis Antonio Panes-Ruiz{1}, Bergoi Ibarlucea{1}, Gianaurelio Cuniberti{1}  
{1}Dresden University of Technology, Germany; {2}Friedrich-Schiller Universität Jena, Germany

#### **8144 Microstructured MOS Gas Sensor as GC Detector**

Oliver Brieger{2}, Julian Joppich{2}, Caroline Schultealbert{1}, Tobias Baur{1}, Christian Bur{2}, Andreas Schütze{2}  
{1}3S GmbH, Germany; {2}Saarland University, Germany



## Technical Program: Monday, 30 May 2022

### **8145 SENSOFT Network: A Wireless Gas Sensing-Sampling Network for Chemical Threats Detection**

Marta Padilla{2}, Moritz Kleinstraß{2}, Miguel Ángel León{1}, Ernesto Gonzalez{3}, Manuel Sparano{1}, Marina Ribas{1}, Ainhua Rezola{4}, Andoni Beriain{4}, Eduard Llobet{3}, Jan Mitrovics{1}

{1}JLM Innovation GmbH, Germany; {2}JLM-Innovation GmbH, Germany; {3}Universitat Rovira i Virgili, Spain; {4}University of Navarra, Spain

### **8080 Response Analysis of Resistor-Type Gas Sensor with Bias Voltage Condition**

Kangwook Choi, Gyuweon Jung, Seongbin Hong, Yujeong Jeong, Wonjun Shin, Jinwoo Park, Chayong Lee, Donghee Kim, Jong-Ho Lee  
Seoul National University, Korea

### **8112 Sub-ppm Detection of H<sub>2</sub>S with CuO-Loaded SnO<sub>2</sub> Hollow Nanospheres Deposited on Interdigitated Electrodes**

Oriane de Leuze{2}, Yann Danlée{4}, Xiaohui Tang{1}, Julien Mahy{3}, Thomas Walewyns{4}, Jean-Pierre Raskin{1}, Sophie Hermans{1}, Laurent Francis{1}

{1}Université Catholique de Louvain, Belgium; {2}Université Catholique de Louvain / VOCsSens, Belgium; {3}University of Liège, Belgium; {4}VOCsSens, Belgium

### **8129 Development of an Automatic 16-Channel Multiplexer Platform for Capacitive Field-Effect Sensors**

Tobias Karschuck{1}, Stefan Schmidt{1}, Stefan Achtsnicht{1}, Arshak Poghosian{3}, Patrick Hermann Wagner{2}, Michael Josef Schöning{1}

{1}Institute of Nano- and Biotechnologies, Aachen University of Applied Sciences, Germany; {2}Laboratory for Soft Matter and Biophysics, Katholieke Universiteit Leuven, Belgium; {3}MicroNanoBio, Germany

### **8131 A Cold Case: TGS 8xx Gas Sensors Electronics**

Patrick Mielle  
ISOCS, France

### **8012 Selectivity of Vapour Trace Detection System**

Ajda Tuševski{2}, Anton Gradišek{1}, Drago Strle{2}

{1}Institut Josef Stefan, Slovenia; {2}University of Ljubljana, Slovenia; {2}University of Ljubljana, Slovakia

### **8016 A Modular Sensor System Design for Instrumental Odor Monitoring**

Wolfhard Reimringer{1}, Julian Joppich{2}, Martin Leidinger{1}, Caroline Schultealbert{1}, Andreas Schütze{2}, Thorsten Conrad{1}

{1}3S GmbH, Germany; {2}Saarland University, Germany

### **8062 Advance in Electronic Nose Technology Developed for the Detection and Discrimination of Ethanol, Ammonia, and Hydrogen Sulfide Gases**

Mohammed Moufid{2}, Carlo Tiebe{1}, Nezha El Bari{2}, Matthias Bartholmai{1}, Benachir Bouchikhi{2}

{1}Bundesanstalt für Materialforschung und -prüfung, Germany; {2}Université Moulay Ismail, Morocco

## Technical Program: Monday, 30 May 2022

### **8069 Electronic Nose Based on Poly(Vinylidene Fluoride)-Modified Nanofibers for Discriminative Detection of Volatile Organic Compounds**

Maria Luisa Braunger{2}, Bruno Henrique Santana Gois{2}, Igor Fier{1}, Vinícius Jessé Rodrigues de Oliveira{2}, Deuber Lincon Da Silva Agostini{2}, Antonio Riul Jr.{3}, Clarissa Almeida Olivati{2}

{1}Quantum Design Latin America, Brazil; {2}São Paulo State University, Brazil;  
{3}University of Campinas, Brazil

### **8085 NanoElectroOptical Nose (NEONOSE) for the Detection of Climate Change Gases**

Félix Meléndez, Patricia Arroyo, José Ignacio Suárez, Pablo Carmona, Juan Álvaro Fernández, José Luis Herrero, Jaime Gómez-Suárez, Diego Carmona, Jesús Lozano  
Universidad de Extremadura, Spain

### **8091 Commercial Metal Oxide Gas Sensors for Breath Analysis Sensitive to Higher Alkane Vapours**

Justin Martin, Anne-Claude Romain  
University of Liège, Belgium

### **8098 VOC Sensing in Humid and Dry Environments**

Carina Esteves, Susana I.C.J. Palma, Henrique M.A. Costa, Cláudia Alves, Gonçalo Santos, Efthymia Ramou, Ana Cecília A. Roque  
Faculdade de Ciências e Tecnologia Universidade Nova de Lisboa, Portugal

### **8042 The Transposition of Mixture Design to Sensory Analysis: A New Approach to Study Odor Mixtures**

Charbel Hawko{3}, Nicolas Hucher{3}, Sabine Crunaire{2}, Céline Léger{1}, Nadine Locoge{2}, Marie Verriele{2}, Géraldine Savary{3}  
{1}AtmoNormandie, France; {2}IMT Nord Europe, France; {3}Université Le Havre Normandie, France

### **8075 Odor Induced Modification of Oscillations and Related Theta-Higher Gamma Coupling in Olfactory Bulb Neurons of Awake Rats**

Ping Zhu{1}, Shuge Liu{1}, Yulan Tian{1}, Yating Chen{1}, Wei Chen{1}, Ping Wang{2}, Liping Du{1}, Chunsheng Wu{1}  
{1}Institute of Medical Engineering, Xi'an Jiaotong University, China; {2}Zhejiang University, Chile

### **8102 Flexible Neural Electrode Array Based- In Vivo Bioelectronic Nose**

Yan Duan, Suhao Wang, Qunchen Yuan, Yingqian Shi, Liujiang Zhuang, Jizhou Song, Ping Wang  
Zhejiang University, China

### **8111 A Bioinspired Olfactory Sensor Based on Organoid-on-a-Chip**

Nan Jiang, Chunlian Qin, Qunchen Yuan, Yan Duan, Mengxue Liu, Liujiang Zhuang, Ping Wang  
Zhejiang University, China

## Technical Program: Monday, 30 May 2022

15:30 - 17:00

Poster session - Signal Processing 2

Room 1, 1<sup>st</sup> floor

### 8013 Clustering of Alpha Curves in Differential Mobility Spectrometry Data

Anton Kondratyev{2}, Osmo Anttalainen{1}, Jussi Rantala{2}, Veikko Surakka{2}, Antti Vehkaoja{2}, Philipp Müller{2}  
{1}Olfactomics, Finland; {2}Tampere University, Finland

### 8053 Study of Quality Controls for Stability Check of the ROIs of a Ketones Mixture in Different GC-IMS Measurement Campaigns

Celia Mallafré-Muro{1}, Meryl Cruz{1}, Arnau Blanco I Borrego{1}, Luis Fernández Romero{1}, Antonio Pardo Martínez{2}, Santiago Marco Colás{1}  
{1}Institute of Bioengineering of Catalonia, University of Barcelona, Spain; {2}University of Barcelona, Spain

### 8065 Towards Batch Correction for GC-IMS Data

Luis Fernández Romero, Arnau Blanco I Borrego, Celia Mallafré-Muro, Santiago Marco Colás  
Institute of Bioengineering of Catalonia, University of Barcelona, Spain

### 8073 Harnessing Thermal Fluctuations for Selectivity Gain

Alexander Vidybida  
Bogolyubov Institute for Theoretical Physics, Ukraine

### 8118 Calibration of Sensor Systems for Odor Monitoring: An Approach and its Limits

Julian Joppich{3}, Wolfhard Reimringer{1}, Thorsten Conrad{1}, Bettina Mannebeck{2}, Christoph Mannebeck{2}, Christian Bur{3}, Andreas Schütze{3}  
{1}3S GmbH, Germany; {2}Olfasense GmbH, Germany; {3}Saarland University, Germany

### 8136 Unsupervised Anomaly Detector to Monitor Ozone Pollution

Benamar Bouyeddou{1}, Fouzi Harrou{2}, Abdelkader Dairi{3}, Ying Sun{2}  
{1}Abou Bekr Belkaid University, Algeria; {2}King Abdullah University of Science and Technology, Saudi Arabia; {3}University of Science and Technology of Oran-Mohamed Boudiaf, Algeria

### 8137 Early Alert System for Odour Management in WWTP

Lidia Saúco{2}, Pilar Pradas{2}, Edurne Ibarrola-Ulzurrun{4}, Jesús Martín{1}, Carlos Lardín{3}  
{1}AMPLIA, Spain; {2}DAM, Spain; {3}ESAMUR, Spain; {4}KUNAK, Spain

### 8138 Estimation of Vessel Emissions and Contribution to Overall Pollution in Port-Cities

Jordi Fonollosa, Daniel Marín López, Javier Nieto Guarasa, Marcella Castells-Sanabra, Anna Muijal-Colilles  
Universitat Politècnica de Catalunya, Spain

### 8130 Uncertainty-Based Performance Evaluation of a Carbon Nanotube-Based Sensor Array Monitoring pH and Active Chlorine in Drink Water

Bérengère Lebental, Guillaume Perrin  
Université Gustave Eiffel, France

## Technical Program: Monday, 30 May 2022

### **8124 A Spiking Neural Network-Based Olfactory Bionic Model for Periodontal Diseases Screening by Exhaled Breath with Electronic Nose**

Yingying Xue, Yizhou Xiong, Weijie Yu, Shimeng Mou, Hao Wan, Ping Wang  
Zhejiang University, China

### **8109 An Auditory and Olfactory Data Fusion Algorithm Based on Spiking Neural Network for Mobile Robot**

Changming Chen, Yingying Xue, Yizhou Xiong, Mengxue Liu, Liuqing Zhuang, Ping Wang  
Zhejiang University, China

17:00 - 18:30

#### **SPECIAL SESSION: Biomimetic Olfactory Biosensors & Bioelectronic Noses**

Small Auditorium, 1<sup>st</sup> floor

Session Chair: Yanxia Hou, CEA

17:00

### **8132 An Overview of Biomimetic Optoelectronic Noses Based on Various Biological Sensing Materials and Surface Plasmon Resonance Imaging**

Yanxia Hou

Université Grenoble Alpes, CEA, CNRS, IRIG-SyMMES, France

17:30

### **8057 Odorant Binding Protein-Based Optoelectronic Nose: Hydration and Protein Activity**

Marielle El Kazzy{2}, Charlotte Hurot{2}, Arnaud Buhot{2}, Lucie Moitrier{1}, Christine Belloir{1}, Loïc Briand{1}, Yanxia Hou{2}

{1}INRA, CNRS, Université de Bourgogne – Franche Comté, Centre des Sciences du Goût et de l'Alimentation, France; {2}Université Grenoble Alpes, CEA, CNRS, IRIG-SyMMES, France

17:50

### **8036 Unfolding Perfumes Using an Optoelectronic Nose**

Pierre Maho{1}, Romain Dubreuil{1}, Léa Têtedoie{1}, Yann Guegan{1}, Johanna Decorps{1}, Cyril Herrier{1}, Farnaz Hanaei{2}, Nadine Vallet{2}, Thierry Livache{1}  
{1}Aryballe, France; {2}ISIPCA, France

18:10

### **8088 Odorant Binding Proteins and Porphyrins Mixed Gas Sensor Array**

Rosamaria Capuano{1}, Khasim Cali{2}, Alexandro Catini{1}, Roberto Paolesse{1}, Krishna Persaud{2}, Corrado Di Natale{1}

{1}Università di Roma Tor Vergata, Italy; {2}University of Manchester, United Kingdom

18:30 – 19:30

#### **ISOCS General Assembly**

Small Auditorium, 1<sup>st</sup> floor

## Technical Program: Tuesday, 31 May 2022

All times stated are local time of Aveiro, Portugal

9:00 – 10:00

### **Keynote: Lifelong Sensors for Overall Health Monitoring and Prevention**

Hossam Haick, *Israel Institute of Technology*

Small Auditorium, 1<sup>st</sup> floor

Session Chair: Corrado di Natale, *University of Rome Tor Vergata*

10:00 - 10:40

### **Sensors**

Small Auditorium, 1<sup>st</sup> floor

Session Chairs: Krishna Persaud, *University of Manchester*

Julian Gardner, *University of Warwick*

10:00

### **8128 Towards a Chip-Based Impedimetric Biosensor for Gaseous H<sub>2</sub>O<sub>2</sub> Detection**

Farnoosh Vahidpour<sup>{1}</sup>, Yousef Alghazali<sup>{1}</sup>, Steffen Thies<sup>{3}</sup>, Gregor Hommes<sup>{3}</sup>,

Michael Josef Schöning<sup>{2}</sup>

<sup>{1}</sup>Aachen University of Applied Sciences, Germany; <sup>{2}</sup>Institute of Nano- and Biotechnologies, Aachen University of Applied Sciences, Germany; <sup>{3}</sup>SKAN Deutschland GmbH, Germany

10:20

### **8097 Learning to See VOCs with Liquid Crystal Droplets**

Susana I.C.J. Palma<sup>{1}</sup>, José Frazão<sup>{2}</sup>, Rita Alves<sup>{1}</sup>, Henrique M.A. Costa<sup>{1}</sup>, Cláudia Alves<sup>{1}</sup>, Hugo Gamboa<sup>{1}</sup>, Margarida Silveira<sup>{2}</sup>, Ana Cecilia A. Roque<sup>{1}</sup>

<sup>{1}</sup>Faculdade de Ciências e Tecnologia Universidade Nova de Lisboa, Portugal;

<sup>{2}</sup>Institute for Systems and Robotics, Instituto Superior Técnico, University of Lisbon, Portugal

10:40 – 11:00

### **Coffee Break**

Foyer, 1<sup>st</sup> floor

11:00 - 12:00

### **Sensors cont.**

Small Auditorium, 1<sup>st</sup> floor

Session Chairs: Krishna Persaud, *University of Manchester*

Julian Gardner, *University of Warwick*

11:00

### **8034 Optimal Bias Conditions for FET-Type Gas Sensors to Minimize Current Fluctuations**

Gyuweon Jung, Jaehyeon Kim, Wonjun Shin, Seongbin Hong, Yujeong Jeong, Jinwoo Park, Donghee Kim, Kangwook Choi, Jong-Ho Lee  
Seoul National University, Korea

11:20

### **8026 2D Fluorescence of QDs-Co<sup>2+</sup> Assembly for the Discrimination of Nucleotides**

Klaudia G?owacz, Marta Doma?ska, Patrycja Ciosek-Skibi?ska  
Warsaw University of Technology, Poland

## Technical Program: Tuesday, 31 May 2022

11:40

### **8028 Development of CeO<sub>2</sub> Embedded Carbon Paste Electrode for Detection of Theophylline in Tea**

Debangana Das<sup>{2}</sup>, Shreya Nag<sup>{1}</sup>, Shubham De<sup>{1}</sup>, Ajanto Kr. Hazarika<sup>{3}</sup>, Santanu Sabhapondit<sup>{3}</sup>, Bipan Tudu<sup>{1}</sup>, Rajib Bandyopadhyay<sup>{1}</sup>, Runu Banerjee Roy<sup>{1}</sup>  
<sup>{1}</sup>Jadavpur University, India; <sup>{2}</sup>Silicon Institute of Technology, Jadavpur University, India; <sup>{3}</sup>Tocklai Tea Research Institute, India

12:00 – 13:20

### **Lunch**

Foyer, 2<sup>nd</sup> floor

13:20 - 14:20

### **Air Quality**

Small Auditorium, 1<sup>st</sup> floor

Session Chair: Nathalie Redon, *IMT Lille Douai*

13:20

### **8002 Remote Drone-to-Drone Gas Sensing: A Feasibility Study**

Patrick P. Neumann, Dino Hüllmann, Nicolas P. Winkler, Jan Schugardt  
Bundesanstalt für Materialforschung und -prüfung, Germany

13:40

### **8047 Implementation of an Instrumental Odour Monitoring System (IOMS) with Variable Thresholds to Predict Citizens' Odour Perceptions**

Beatrice Julia Lotesoriere, Carmen Bax, Laura Capelli  
Politecnico di Milano, Italy

14:00

### **8040 Hyper Resoluted Air Quality Maps in Urban Environment with Crowdsensed Data from Intelligent Low Cost Sensors**

Saverio De Vito, Grazia Fattoruso, Gerardo D' Elia, Elena Esposito, Sergio Ferlito, Antonio Del Giudice, Ettore Massera, Giuseppe Loffredo, Girolamo Di Francia  
ENEA, Italy

14:20 - 16:20

### **Sniffest Competition**

Room 4, 1<sup>st</sup> floor

14:20 - 16:20

### **Poster session - Electronic Tongues 2**

Room 1, 1<sup>st</sup> floor

### **8015 Microneedle-Based Extended Gate Sensor for Minimally-Invasive Potassium Detection**

Youbin Zheng, Jing Wang, Rawan Omar, Hossam Haick  
Technion - Israel Institute of Technology, Israel

## Technical Program: Tuesday, 31 May 2022

### **8027 Sensitive Electrochemical Detection of Carvacrol Using Carbon Paste Electrode**

Sounak Banerjee{1}, Hemanta Naskar{1}, Barnali Ghatak{1}, Shreya Nag{1}, Debangana Das{3}, Runu Banerjee Roy{1}, Nityananda Das{2}, Bipan Tudu{1}, Rajib Bandyopadhyay{1}  
{1}Jadavpur University, India; {2}Jagannath Kishore College, India; {3}Silicon Institute of Technology, Jadavpur University, India

### **8029 A Gold Nanoparticle Decorated Carbon Paste Based Electrochemical Sensor for Enhanced Vanillin Detection**

Shreya Nag{1}, Debangana Das{2}, Dipan Bandyopadhyay{1}, Bipan Tudu{1}, Rajib Bandyopadhyay{1}, Runu Banerjee Roy{1}  
{1}Jadavpur University, India; {2}Silicon Institute of Technology, Jadavpur University, India

### **8030 Determination of Epicatechin Content in Green Tea Samples Using Near Infrared Spectroscopy**

Debangana Das{2}, Shreya Nag{1}, Sawon Bhowmik{1}, Ajanto Kr. Hazarika{3}, Santanu Sabhapondit{3}, Bipan Tudu{1}, Rajib Bandyopadhyay{1}, Runu Banerjee Roy{1}  
{1}Jadavpur University, India; {2}Silicon Institute of Technology, Jadavpur University, India; {3}Tocklai Tea Research Institute, India

### **8037 An e-Tongue with Flexible Nanostructured Sensors for Impedimetric Detection of Ibuprofen in Water**

Ítalo Costa{2}, Leonardo Paterno{2}, Olfa Kanoun{1}, Ammar Al-Hamry{1}  
{1}Technische Universität Chemnitz, Germany; {2}Universidade de Brasília, Brazil

### **8049 Influence of Surfactant and Chromoionophore Type on the Performance of Generic Lipophilic Anion-Sensitive Nanospheres**

Aleksandra Kalinowska, Patrycja Agata Matusiak, Patrycja Ciosek-Skibińska  
Warsaw University of Technology, Poland

### **8061 Simultaneous Assessment of Volatile Organic Compound-Based Urinary and Exhaled Breath Tests for Diabetes Diagnosis by Using E-Nose and VE-Tongue Systems**

Omar Zaim, Hafsa Elyoubi, Nezha El Bari, Benachir Bouchikhi  
Université Moulay Ismail, Morocco

### **8127 Studying the Immobilization of Acetoin Reductase with Tobacco Mosaic Virus Particles on Capacitive Field-Effect Sensors**

Melanie Welden{1}, Robin Severins{1}, Arshak Poghosian{3}, Christina Wege{5}, Petra Siegert{1}, Michael Keusgen{4}, Michael Josef Schöning{2}  
{1}FH Aachen – Aachen University of Applied Sciences, Germany; {2}Institute of Nano- and Biotechnologies, Aachen University of Applied Sciences, Germany; {3}MicroNanoBio, Germany; {4}Philipps University Marburg, Germany; {5}University of Stuttgart, Germany

### **8135 Shiga Toxin-Producing E.coli (STEC) ss-DNA Detection by Silve-Chitosan SERS Substrate**

Yuqing Yang, Luiza Adela Wasiewska, Alan O'Riordan, Pierre Lovera  
Tyndall National Institute, Ireland

## Technical Program: Tuesday, 31 May 2022

### **8141 Saliva Enzymes and In-Mouth pH Changes Impact on the Perception of Alcoholic Beverages Flavor: A Preliminary Study for the Development of an E-Flavor**

Maria João Santos{2}, Elisete Correia{3}, Gonçalo Rijo{1}, Alice Vilela{2}  
{1}Neoeption, Portugal; {2}University of Trás-os-Montes e Alto Douro, Portugal; {3}UTAD, Portugal

### **8068 Bioelectronic Nose and Bioelectronic Tongue In Vitro and In Vivo**

Ping Wang, Yong Qiu, Xianyou Sun, Qunchen Yuan, Chunlian Qin, Liujing Zhuang  
Zhejiang University, China

### **8074 A Taste Bud Organoid-Based MEA Biosensor for Taste Sensation**

Shuge Liu, Ping Zhu, Yulan Tian, Yating Chen, Yage Liu, Wei Chen, Liping Du, Chunsheng Wu  
Institute of Medical Engineering, Xi'an Jiaotong University, China

### **8092 A Biomimetic Cardiomyocyte-Based Biosensor for the Detection of Medium Chain Fatty Acids**

Yating Chen, Liping Du, Ping Zhu, Shuge Liu, Donxin Liang, Chunsheng Wu  
Institute of Medical Engineering, Xi'an Jiaotong University, China

### **8103 A Novel and Sensitive Detection Method of Hydrogen Peroxide and Glucose Based on Copper Nanoclusters**

Shuqi Zhou{2}, Xinyi Wang{2}, Liubing Kong{2}, Wencheng Lin{2}, Chiyu Ma{2}, Xianyou Sun{2}, Zhuoru Huang{2}, Kejing Ying{1}, Hao Wan{2}, Ping Wang{2}  
{1}Sir Run Run Shaw Hospital, Zhejiang University, China; {2}Zhejiang University, China

### **8123 The Love Wave Biosensor for the Detection of the Bacterial Pneumonia Biomarker C-Reactive Protein**

Junyu Zhang{2}, Xiaojing Zhang{2}, Hangming Xiong{2}, Weijie Yu{2}, Kejing Ying{1}, Hao Wan{2}, Ping Wang{2}  
{1}Sir Run Run Shaw Hospital, Zhejiang University, China; {2}Zhejiang University, China

14:20 - 16:20

#### **Poster session - Applications**

Room 1, 1<sup>st</sup> floor

### **8086 Detection of TCA in Cork Stoppers Using an Electronic Nose**

Félix Meléndez{3}, Patricia Arroyo{3}, Jaime Gómez-Suárez{3}, José Pedro Santos{2}, Francisco Javier Yuste{1}, Belén Godoy{1}, Máximo García{1}, José Ignacio Suárez{3}, Jesús Lozano{3}  
{1}CICYTEX, Spain; {2}Institute of Physics Technology and Information, ITEFI-CSIC, Spain; {3}Universidad de Extremadura, Spain

### **8070 Prediction of Intrinsic Quality Parameters of Cardamom Using an Electronic Nose**

Alokesh Ghosh{1}, Devdulal Ghosh{1}, Tarun Kanti Ghosh{1}, Madhurima Ghosh{4}, Hena Ray{1}, Amitava Akuli{1}, Om Krishan Singh{3}, Nabarun Bhattacharyya{1}, Rajib Bandyopadhyay{2}  
{1}Centre for Development of Advanced Computing, India; {2}Jadavpur University, India; {3}Ministry of Electronics and Information Technology, India; {4}St. Thomas' College of Engineering and Technology, India



## Technical Program: Tuesday, 31 May 2022

### **8106 Bread Baking Monitoring by Smart Sensory System: A Feasibility Study**

Bianca Di Diodoro{2}, Carmen Bax{2}, Nicolò Dellarosa{1}, Flavio Corazza{1}, Giacomo Langfelder{2}, Laura Capelli{2}  
{1}Electrolux Italia S.p.A., Italy; {2}Politecnico di Milano, Italy

### **8005 People Stink: Towards Identification of People from Breath Samples**

Katri Salminen{2}, Jussi Rantala{1}, Philipp Müller{1}  
{1}Tampere University, Finland; {2}Tampere University of Applied Sciences, Finland

### **8125 A Stand-Alone Multi-Scent Olfactory Display with a Sliding Scent Switching Mechanism**

Chuhong Wang, Sammy Hassan, James Covington  
University of Warwick, United Kingdom

### **8077 Pneumopipe-Sense: Tailoring Breath Collection and Analysis for Mobile Points-of-Care**

Alessandro Zompanti, Anna Sabatini, Antonio Mortella, Simone Grasso, Marco Santonico, Giorgio Pennazza  
University Campus Bio-Medico di Roma, Italy

### **8003 Classification of Urine Odour Using Machine Learning Methods**

Yuxin Xing, Julian Gardner  
Warwick University, United Kingdom

### **8044 Discrimination of Indian Cardamom Using an Array of QCM Sensors**

Nilava Debabhuti{3}, Sumani Mukherjee{5}, Subhojit Malik{2}, Sourav Manna{4}, Prolay Sharma{3}, Bipan Tudu{3}, Nabarun Bhattacharyya{1}, Rajib Bandyopadhyay{3}  
{1}Centre for Development of Advanced Computing, India; {2}Hooghly Engineering & Technology, India; {3}Jadavpur University, India; {4}Presidency University, Kolkata, India; {5}St. Thomas' College of Engineering and Technology, India

### **8045 A Bench Test System for Developing E-Nose Diagnostic Tools with Exhaled Breath Sampling**

Stefano Robbiani, Carmen Bax, Jody Albertazzi, Margherita Pappolla, Valentina Busini, Laura Capelli, Raffaele Dellaca  
Politecnico di Milano, Italy

### **8055 Food Quality Monitoring by Portable Electronic Nose Based on Organic Field-Effect Transistors**

Daniil Anisimov, Anton Abramov, Victoria Chekusova, Askold Trul, Elena Agina, Sergei Ponomarenko  
Institute of Synthetic Polymeric Materials, Russian Academy of Science, Russia

### **8067 Identification of Aromatic Rice Varieties Using Machine Learning Enabled Electronic Nose**

Arun Jana{1}, Om Krishan Singh{2}, Amitava Akuli{1}, Tapas Sutradhar{1}, Sibani Das{1}, Souvagya Chatterjee{1}, Nabarun Bhattacharyya{1}  
{1}Centre for Development of Advanced Computing, India; {2}Ministry of Electronics and Information Technology, India

## Technical Program: Tuesday, 31 May 2022

### **8093 Detection of the Fungal Infection in Post-Harvest Onions by an Electronic Nose**

Malgorzata Labanska{1}, Sascha Jenkins{2}, Sarah van Amsterdam{2}, John Clarkson{2}, James Covington{2}

{1}Plant Breeding and Acclimatization Institute - National Research Institute, Poland;

{2}University of Warwick, United Kingdom

### **8006 Metal Oxide Semiconductor Gas Sensors-Based E-Nose and Two-Stage Classification: Authentication of Malaysia and Vietnam Black Pepper Samples**

Hui En Lee{4}, Zehnder Mercer{1}, Sing Muk Ng{2}, Mahnaz Shafiei{3}, Hong Siang Chua{4}

{1}Malaysian Pepper Board, Malaysia; {2}Sarawak Energy Berhad, Malaysia;

{3}Swinburne University of Technology, Australia; {4}Swinburne University of Technology Sarawak Campus, Malaysia

### **8020 Versatile Electronic Nose for the Detection of Chronic Disease Biomarkers Through the Breath**

José Pedro Santos{1}, Carlos Sánchez Vicente{1}, Isabel Sayago{1}, Jesús Lozano{2}, Patricia Arroyo{2}

{1}Institute of Physics Technology and Information, ITEFI-CSIC, Spain; {2}Universidad de Extremadura, Spain

### **8071 In-Situ Breath Analysis for Non-Invasive Diabetes Detection**

Tarun Kanti Ghosh{1}, Alokesh Ghosh{1}, Hena Ray{1}, Angshuman Chakraborty{1}, Ravi Sankar{1}, Om Krishan Singh{3}, Nabarun Bhattacharyya{1}, Rajib Bandyopadhyay{2}

{1}Centre for Development of Advanced Computing, India; {2}Jadavpur University, India;

{3}Ministry of Electronics and Information Technology, India

### **8087 Electronic Nose for Stress Detection in Engineering Students During Covid-19 Pandemic**

Cristhian Manuel Durán Acevedo, Jeniffer Katherine Carrillo Gómez, Camilo Andrés Albarracín Rojas

University of Pamplona, Colombia

### **8100 Smart Electronic Nose for the Detection of Exhaled Breath to Diagnose Small Intestinal Bacterial Overgrowth**

Weijie Yu{2}, Shimeng Mou{2}, Yingying Xue{2}, Hangming Xiong{2}, Yanjie Hu{1}, Hao Wan{2}, Ping Wang{2}

{1}Sir Run Run Shaw Hospital, Zhejiang University, China; {2}Zhejiang University, China

### **8105 Olfactory Bulb Biosensor Monitoring the Effect of Treatment Drugs for AD In Vitro**

Mengxue Liu, Changming Chen, Qunchen Yuan, Liuqing Zhuang, Ping Wang  
Zhejiang University, China

### **8110 Design of Breath Sampling Device and Procedure for Volatile Organic Compounds and Exhaled Breath Condensate**

Hangming Xiong{2}, Jiaying Sun{2}, Yingying Xue{2}, Weijie Yu{2}, Yong Zhou{1}, Hao Wan{2}, Ping Wang{2}

{1}Sir Run Run Shaw Hospital, Zhejiang University, China; {2}Zhejiang University, China

## Technical Program: Tuesday, 31 May 2022

16:40 - 17:40

### Healthcare Applications

Small Auditorium, 1<sup>st</sup> floor

Session Chair: Hossam Haick, *Technion*

16:40

#### **8120 Overview on VOGAS: An Instrument Combining Two Gas Sensing Techniques for Disease Diagnosis**

Marta Padilla{1}, Miguel Ángel León{1}, Johannes Glöckler{4}, Tesfalem Welearegay{5}, Gidi Shani{3}, Boris Mizaikoff{4}, Lars Österlund{5}, Jan Mitrovics{1}, Hossam Haick{2}{1}JLM-Innovation GmbH, Germany; {2}Technion - Israel Institute of Technology, Israel; {3}Technion Israel Institute of Technology, Israel; {4}Ulm University, Germany; {5}Uppsala University, Sweden

17:00

#### **8025 A Novel Approach for the Non-Invasive Diagnosis of Prostate Cancer Based on Urine Odour Analysis**

Carmen Bax{2}, Laura Capelli{2}, Fabio Grizzi{1}, Stefano Prudenza{2}, Gianluigi Taverna{1}{1}IRCCS Humanitas Research Hospital, Italy; {2}Politecnico di Milano, Italy

17:20

#### **8058 Urinary Volatile Recognition for COVID-19 Diagnosis**

Yolande Christelle Ketchanji Mougang, Lorena Di Zazzo, Rosamaria Capuano, Marilena Minieri, Corrado Di Natale  
Università di Roma Tor Vergata, Italy

17:40 - 18:40

### Robotic Applications

Small Auditorium, 1<sup>st</sup> floor

Session Chair: Achim Lilienthal, *Örebro University*

17:40

#### **8081 On Gas Source Declaration Methods for Single-Robot Search**

Pepe Ojeda, Javier Monroy, Javier Gonzalez-Jimenez  
University of Málaga, Spain

18:00

#### **8041 Experimental Analysis of the Impact of Sensor Response Time on Robotic Gas Source Localization**

Pepe Ojeda, Javier Monroy, Javier Gonzalez-Jimenez  
University of Málaga, Spain

18:20

#### **8063 Gas Dispersion Simulator with Strong Fluctuations for Developing Gas Source Localization Systems**

Motoki Sakaue{1}, Yusuke Takahashi{1}, Haruka Matsukura{2}, Hiroshi Ishida{1}{1}Tokyo University of Agriculture and Technology, Japan; {2}University of Electro-Communications, Japan

20:00 – 23:00

### Conference Dinner

Hotel Meliá, Banquet Hall

## Technical Program: Wednesday, 1 June 2022

All times stated are local time of Aveiro, Portugal

9:00 – 10:00

### **Experiences in the Detection of Drugs of Abuse in Smuggling Seizures and Forensic Samples Using Electronic Tongue Principles**

Manel Del Valle, Universitat Autònoma de Barcelona

Small Auditorium, 1<sup>st</sup> floor

Session Chair: Sandrine Isz, *Alpha MOS*

10:00 - 12:20

### **Signal Processing 1**

Small Auditorium, 1<sup>st</sup> floor

Session Chair: Santiago Marco, *Institute for Bioengineering of Catalonia*

10:00

### **8011 Global Calibration Models Match Ad-Hoc Calibrations Field Performances in Low Cost Particulate Matter Sensors**

Saverio De Vito, Gerardo D'Elia, Girolamo Di Francia

ENEA, Italy

10:20

### **8017 Regression Model for the Prediction of Pollutant Gas Concentrations with Temperature Modulated Gas Sensors**

Arne Kobald, Udo Weimar, Nicolae Bârsan

University of Tuebingen, Germany

10:40 – 11:00

### **Coffee Break**

Foyer, 1<sup>st</sup> floor

11:00 - 12:20

### **Signal Processing 1 cont.**

Small Auditorium, 1<sup>st</sup> floor

Session Chair: Santiago Marco, *Institute for Bioengineering of Catalonia*

11:00

### **8035 Transfer Learning to Significantly Reduce the Calibration Time of MOS Gas Sensors**

Yannick Robin, Johannes Amann, Payman Goodarzi, Andreas Schütze, Christian Bur  
Saarland University, Germany

11:20

### **8038 Towards Gas Identification in Unknown Mixtures Using an Electronic Nose with One-Class Learning**

Han Fan, Daniel Jonsson, Erik Schaffernicht, Achim J. Lilienthal

Örebro University, Sweden

## Technical Program: Wednesday, 1 June 2022

11:40

### **8023 Super-Resolution for Gas Distribution Mapping: Convolutional Encoder-Decoder Network**

Nicolas P. Winkler{1}, Haruka Matsukura{4}, Patrick P. Neumann{1}, Erik Schaffernicht{2}, Hiroshi Ishida{3}, Achim J. Lilienthal{2}  
{1}Bundesanstalt für Materialforschung und -prüfung, Germany; {2}Örebro University, Sweden; {3}Tokyo University of Agriculture and Technology, Japan; {4}University of Electro-Communications, Japan

12:00

### **8024 Separation of Pure Perfume Mass Spectrum from Interferences Using ICA**

Dani Prasetyawan, Takamichi Nakamoto  
Tokyo Institute of Technology, Japan

12:20 – 12:30

### **Presentation by the Sniffest Competition Winner**

Small Auditorium, 1st floor

12:30 – 13:50

### **Lunch**

Foyer, 2<sup>nd</sup> floor

13:50 – 14:20

### **Closing and Award Ceremony**

Small Auditorium, 1<sup>st</sup> floor