Anal Bioanal Chem (2016) 408:7229–7230
DOI 10.1007/s00216-016-9838-8

EDITORIAL

Chemical sensing: from new materials to in vivo applications

Maria Careri[1] · **Marco Giannetto**[1] · **Renato Seeber**[2]

Published online: 12 August 2016

This topical collection includes articles and reports from researchers working in the field of chemical sensing and focuses on high-level innovations to physical systems and measurements procedures. Italian researchers have been especially invited to contribute as the idea behind this topical collection was the necessity to showcase research in sensing in Italy. The invited contributions from foreign groups definitely enrich the collection.

Each article has been designed as a tool to highlight the advantages in using chemical sensors and biosensors with respect to laboratory equipment.

We believe that the time has arrived for the scientific community operating in the field of sensors to shift the focus of the sensing activity closer to 'the field' i.e. to also take stock of the many systems recently proposed and to verify the relevant capability of chemical sensing technology to work in real matrices. The key advantage of sensors with respect to laboratory instrumentation, in fact, lies in the possibility to work in-line or on-line, rather than at-line or off-line. In similar situations, sensors exhibit major advantages, allowing continuous monitoring of an evolving system, bearing maximum information content over time, not requiring time-consuming sample collection, expensive transport and pre-treatment of the samples and, finally, consisting of possibly portable and low-cost devices. The availability of cheaper, more sensitive and sophisticated sensors for gases, particulates, water systems and other environmental measurements enables researchers to collect data at an unprecedented rate and scale. As a counterpart of all these appealing points in favour of sensors, they should be suitable to give repeatable responses, which do not suffer from memory effects resulting from previous measurements, or from 'matrix effects', and even be remotely controlled.

In an analytical panorama in which very expensive laboratory instrumentation, often constituting a black box for the user, exhibits more and more powerful capability in analysis and automation, sensors have to take up the challenge in a complementary field. New sensors may potentially overcome the limitations of traditional clinical and environmental analysis by improving the quality of data at the level of all performance indicators, frequency of measures included. In addition, the technological advances in sensors and development of materials possessing innovative properties, especially in electrochemical and bioelectrochemical analysis, open new perspectives to chemical sensing for real-world samples.

The realisation of a wide number of selective sensing elements and the robustness of devices and measurement procedures illustrate the further added value of sensors. Integration of physics, analytical chemistry, biology, materials science and electronics is often desirable for the development and application of novel devices within the sensor community. As more data become available from sensor systems, knowledge of chemometrics is also necessary to achieve proper treatment of the data collected.

The present issue of ABC aims to encourage expert researchers in the fields of optics and electrochemistry, and also in chemometrics, to invest time and money in research projects devoted to innovation in chemical sensing. The approach could rely on the development, characterisation and testing of novel materials for sensing, on the definition of effective procedures for direct application of sensing systems to complex real matrices as well as on the definition of sampling

Published in the topical collection *Chemical Sensing Systems* with guest editors Maria Careri, Marco Giannetto, and Renato Seeber.

✉ Marco Giannetto
marco.giannetto@unipr.it

[1] Department of Chemistry, Università di Parma, Parco Area delle Scienze 17/A, 43124 Parma, Italy

[2] Department of Chemical and Geological Sciences, Università di Modena and Reggio Emilia, Via G.Campi, 103, 41125 Modena, Italy

strategies, both in space and time, for continuous monitoring in heterogeneous real complex systems, and finally on the application of experimental design techniques for best efficiency of a single sensor and of a sensor network, with the aim of a full validation of the sensing system as a whole. Finally, treatment of signals and data from single sensors and sensor assemblies should complete the analytical process.

This collection compiles the expert knowledge of many specialists in the construction and use of chemical sensors and biosensors, including disposable amperometric immunosensors for food safety and quality assessment, surface plasmon biosensors for detection of pregnancy, genosensors, hyperspectral sensors etc., thus combining the expertise of otherwise apparently unrelated disciplines of chemistry, physics, biology, medical sciences and electronic engineering. Emphasis is placed on practical problems, ranging from chemical applications to biomedical monitoring and from in vitro to in vivo.

The analysis of biological fluids is also challenged, suiting the performance of new photo-renewable materials for amperometric detection of neurotransmitters. Conducting polymers for electrochemical sensing are also tackled both in a feature article and in a research paper dealing with PEDOT-modified electrodes for quality assessment of wines. The majority of the developed devices are implemented on disposable screen-printed electrodes, properly modified with metal or carbon nanostructures; thus highlighting the versatility and high performance of similar platforms.

Sensing devices aimed at specific recognition of genetic material, such as nucleic acids, by impedimetric transduction, are addressed in a paper in forefront as well as in a critical review focused on the biosensing of tumor-associated DNA freely circulating in blood useful for early detection of cancer from a liquid biopsy. Label-free electrochemical genosensors based on mesoporous silica thin film are also evaluated in a research paper.

Data dimensionality reduction and fusion techniques are addressed in a research paper aimed at the characterisation of coffee samples by hyperspectral sensors.

Finally, a further goal of this topical collection was underlined in a round table held at a recent Italian meeting in Parma. On that occasion experts underlined the need for financial support by companies and even by institutions to propose high-level innovations in the realisation of sensing systems for emerging issues, still considered by some researchers as ‘niche’ fields. Among many examples, let us cite the cases of compounds occurring in industrial environments, often present at unusually high concentrations, i.e. conditions that are often overlooked, of home-made explosives, of systems for ‘ambient assisted living’, for continuous monitoring of surgical site infections and for point-of-care monitoring.

This collection of articles constitutes a convincing overview of the key points that ascribe specific roles to sensing: the choice of the most suitable competencies has also considered the effectiveness in pursuing such an objective.

Maria Careri Full Professor of Analytical Chemistry at the University of Parma since 2001, she is Director of the Department of Chemistry of Parma University since 2012. She is also Director of the National School of “Analytical and Bioanalytical Methodologies Based on Mass Spectrometry” of the Italian Chemical Society, which has been held in Parma since 2005.

She is a member of the International Advisory Boards of *Analytical and Bioanalytical Chemistry* and *Current Analytical Chemistry*. Author of more than 180 peer-reviewed publications, including encyclopaedia entries and book reviews, for the last 10 years her research activities have centred on the development of mass-spectrometry-based methods for food safety, environmental monitoring and forensics. Her current research interests include the development of biosensors and of novel materials for desorption electrospray ionisation and matrix-assisted laser desorption/ionisation mass spectrometry with a focus on the characterisation of surfaces.

Marco Giannetto Researcher and Assistant Professor at the Department of Chemistry of the University of Parma, Italy, since 2001. His scientific activity is focused on the realisation and characterisation of chemical sensors and biosensors based on innovative recognition materials, combining nanostructures with bioreceptors and different transduction mechanisms, ranging from potentiometric to amperometric as well as piezoelectric systems. He is author of more than 40 papers published in international peer-reviewed journals.

Renato Seeber Professor of Analytical Chemistry at the University of Modena and Reggio Emilia, Italy. He is co-author of more than 200 peer-reviewed publications, including chapters of books and one book; he has been editor and co-editor of special issues for different journals. He is a member of the International Advisory Board of *Analytical and Bioanalytical Chemistry*. His current interests are in the field of electrochemical sensing, of the treatment of signals and data through filtering techniques, in developing and applying algorithms for multivariate analysis and regression. Similar approaches are also used in the frame of sensing elements for ‘electronic tongues’.