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EDITORIAL

New developments in biosensors

Francesco Baldini[1] · Maria Minunni[2]

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Looking back in time, one of the first biosensors can be considered the urea sensor developed by Guilbault and Montalvo in 1969 with the urease enzyme immobilized over an ion selective electrode responsive to ammonium ions (G.G. Guilbault, J.G. Montalvo Jr, *Anal.Lett*, 2(5), 283-293 (1969)). Since then, the area of biosensors has increased continuously, becoming one of the most important interdisciplinary areas, with applications ranging from medicine, to environmental monitoring, food analysis, and online control in industrial processes.

According to the IUPAC definition given in 1992, a biosensor is "a device that uses specific biochemical reactions mediated by isolated enzymes, immunosystems, tissues, organelles or whole cells to detect chemical compounds usually by electrical, thermal or optical signals" (B Nagel, H Dellweg, LM Gierasch, PAC, 1992, 64, 143). As a matter of fact, since 1992, other approaches were proposed based on novel sensing principles using recognition elements not included in the above-mentioned definition (e.g., biomimetic approaches with molecular imprinted polymers, aptamers, and oligonucleotidic sequences); therefore, the definition of biosensor can be extended to a device which makes use of biological elements and/or biochemical reactions to detect chemical compounds by electrical, thermal, piezoelectric, or optical signals.

In the biomedical area, one of the areas where biosensors are playing a fundamental role is surely represented by Point of Care, with the strong clinical demand for detection of chemicals and biochemicals in the immediate proximity of the patient. This deep request implies the transfer of the analytical techniques implemented in central laboratories by means of traditional equipment and instrumentation into compact and transportable devices.

Two critical reviews are included in this topical collection with the purpose of providing a view on the present situation with a look to the potential scenarios which new technologies are opening.

The idea of this topical collection on biosensors comes to us in relation to our deep involvement, as chairpersons, in the organization of the 2nd European Biosensor Symposium, held in Florence from 18 to 21 February 2019. In relation to this event, let us spend a few words to thank the University of Florence for the provision of the infrastructures for the 2nd European Biosensor Symposium and the Italian Society of Optics and Photonics for their strong support in the organization of this event.

Whichever is the detection principle utilized, the advent of nanotechnology can offer a strong impulse in the development of highly performant biosensors by means of the use of either nanostructured nanoparticles in the biochemical reactions or nanostructured coatings in the sensing element. On this topic, the topical collection includes an interesting paper; the influence of the shape of gold nanoparticles on the catalytic current in graphite electrodes is deeply investigated.

Biomimetic receptors have also recently enriched the portfolio of binding elements to be used in biosensing. In this category, fall aptamers. Aptamers have been described as oligonucleotide or peptide molecules able to selectively bind to a target molecule (analyte). Aptamers are usually selected starting from a large random sequence pool, enriched in sequences with high affinity for the target and amplified. Here, two applications of aptamers are presented for the detection of a cardiac biomarker, Troponin T by means of an electrochemical sensor and the important contaminant aflatoxin B1 with an optical approach. Application to the detection of water pollutants is reported by both electrochemical and optical bacterial sensors.

Published in the topical collection *New Developments in Biosensors* with guest editors Francesco Baldini and Maria Minunni.

✉ Francesco Baldini
f.baldini@ifac.cnr.it

[1] Istituto di Fisica Applicata "Nello Carrara" - CNR, Via Madonna del Piano 10, Sesto Fiorentino, 50019 Firenze, Italy

[2] Department of Chemistry, University of Florence, Via della Lastruccia 3, Sesto Fiorentino, 50019 Firenze, Italy

Efforts in developing new materials for sensing has been also reported, with approaches spanning from polymeric surfaces for SPR immunosensing to new electrocatalytic material ($NdFeO_3$).

Cellular-based platforms carrying enhanced green fluorescence protein (EGFP) and red fluorescence protein (RFP) genes under the control of selected genes are also included in this topical collection with application to drug development. In particular, induction ability of compounds on the transcription in erythroid cells of γ-globin and β- globin genes is evaluated with interest in experimental therapy of β-thalassemia and sickle cell anemia.

Besides these, interaction studies of protein-nucleic acid in mutated Aγ-globin gene by SPR and of DNA-protein biomarkers in a microfluidic microbead chip of cardiovascular disease interest are included as examples of biosensor impact on basic research.

The assessment on environmental real samples of an enzymatic biosensor for *E. coli* detection in fresh and salt water is also reported.

A suitable data processing is always an important issue in the development of any type of sensors, clearly including also biosensors, and an interesting analysis of electrochemical measurements with an artificial neural network for the discrimination of different classes of pollutants is included in this topical collection.

Our sincere thanks go to all the authors for their precious contribution to this special issue which in our hopes should provide a sort of flavor of the state of development and progress of the area of biosensing, without any pretension of being exhaustive, and clearly to all the reviewers who with their criticism and suggestions improved the quality of the accepted papers.

Francesco Baldini is senior scientist at the Institute of Applied Physics "Nello Carrara" of the National Research Council. His research interests have been devoted to the development of optical fiber sensors and to the application of optical methods to the restoration of paintings and frescoes. Since the end of the 1990s, his activity has been mostly devoted to the design and development of optical sensors for the detection of chemical and biochemical parameters, and in the last 10 years, he focused his research mainly to the development of optical sensors for clinical diagnostics and to the development of nanosensing probes at intracellular levels. He is the author of about 200 publications on the subject in International Journals, in scientific books, and in International Conference Proceedings with three plenary talks and twenty-eight invited talks at international conferences. He is/was a coordinator and/or responsible of many international and national projects in the field of optical chemical and biochemical sensors. In 2009, he was nominated fellow of SPIE for "his achievements in biological and chemical sensing in biomedicine" and he was President of the Italian Society of Optics and Photonics (SIOF) for the biennium 2015–2016.

Maria Minunni is full professor in Analytical chemistry at Chemistry Department "Ugo Schiff," University of Florence. Her interests are focused on optical and piezoelectric biosensors, affinity sensing, biomimetic receptors (aptamers, molecular imprinted polymers), and nanophotonics.