Journal of Analytical & Pharmaceutical Research

Opinion

Bioanalytics-not a word but a World

Volume 2 Issue 6 - 2016

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Received: July 11, 2016 | **Published:** July 20, 2016

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In many spheres of human practical activity, even at the highest level of science and technology, one cannot create mechanisms and devices as perfect as those created by nature during the process of evolution over many millions of years. All living organisms (biomolecules) in an active state interact with the habitat and require the environment to be of a strictly specified composition for proper survival. If the chemical composition is changed by the introduction or removal of a component, the organism will give a response. The response of the organism -as an indicator- can be transformed to an analytical signal, which serves as an intact measure of the qualitative estimation or the quantitative determination of the chemical composition, specially at on-site. *This is the Bioanalytics; surely is not a word but a world.* The potential of bioanalytics lies in highlighting and meeting new challenges in the fields of medicine, ecology and nutrition and in the rapid technical progress it is currently undergoing.

Although detection and identification of biomolecules (as two main parts of this *world*) have been enabled by the progress in both molecular biology and detection technology in the past, there is no standard use yet directly at the various points of interest (on-site). In this way, to fully explore their potential socioeconomic impact, they would have to be applied routinely and preferably at (or near) on-site. In order to address this requirement, micro- and nanotechnologies as a certain set of bioanalytical technologies has been proposed based on optical detection in microsystems.

Optical detection can rely on various properties of light which are used as measurement signal, such as intensity (photometry), the description of light as composed of a set of fundamental primary colors (such as RGB) in colorimetry, the use of molecules exhibiting fluorescence, or the extended spectral decomposition as done in spectroscopic methods. Fluorescence and spectroscopic techniques allow for a new quality in sensitivity and differentiation, respectively, which could open possibilities for applications not covered by the simpler techniques.

Another important aspect of the described approaches is the application of optical sensors and biosensors in analytical assays. These wonderful systems have become very widespread in the last two decades and are nowadays applied in bioanalytics. The most common sensor types include planar sensor foils and spots, fiber optic sensors, and microsensors. Versatile as they are, optical sensors still have several limitations, arising mostly from their dimensions. First, the response times are often too long to,monitor fast processes such as enzymatic reactions. Second, they are unsuitable for microscopy and microfluidics. Finally, certain sensor formats (planar foils and paints) allow imaging, but it is restricted to a surface and cannot be performed in a volume. Although miniaturization of fiber optic sensors to sub-micron size is possible, such sensors are expensive and the handling is often tedious. At first glance, dissolved indicators appear to overcome these limitations by being highly flexible, simple to use, and often low cost. Especially in high throughput applications, with small sample volumes they are usually the sensing tools of choice.

However, several drawbacks significantly compromise the performance of such systems and even render many dissolved indicators practically useless. These drawbacks include low selectivity and sensitivity, high toxicity, tendency to aggregation, liability to non-specific binding, and restriction to water-soluble indicators only. Optical nanosensors represent advanced analytical tools that combine the robustness of conventional optical sensors with flexibility of dissolved indicators. Features of these sensors include the possibility of measuring in very small volumes (including single cells), suitability for 3D imaging, low toxicity, high selectivity, low effect of non-specific binding and other interferences (such as water) on sensor properties, and versatility in tuning most properties within the polymer matrix.[1–3]

As a consequence, the integration of the several components such as microfluidics, actuators, and optical detection devices is a key issue for the field. Supported by technical developments in the field of miniaturization and optics, approaches have been established allowing for the combination of optical approaches with microfluidics and microsystems. These present the fast development in the field, which ensures that over the next years we will witness these techniques finding increasing applications in real-world applications.

Acknowledgments

None.

Conflicts of interest

The authors declare there is no conflict of interests.

Funding

None.

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