Nanotechnology enabled microsensors

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Background and state of the art

More and more, the development of systems for chemical detection that can work in the micron and sub-micron scale is becoming of utmost relevance in analytical chemistry. This is in part due to the increasingly important role micro and nano-fluidic devices in current and future chemical analysis. In order to take full advantage of their features, this wave of miniaturized devices are demanding the adaptation and re-design of current detection approaches to the small scale.

But acting as tiny detectors is just one side of their uses. An even more challenging application of these micro sensors is the generation of spatially resolved chemical data. For example, in order to understand metabolic pathways, cell signalling and other complex processes of living organisms, it is essential not only to detect chemical species, but know exactly –with a higher and higher level of precision- where exactly they are located. Furthermore, in order to perform in vivo studies, the disruption caused by the introduction of sensing devices should be minimized. In summary, developing miniaturized sensing devices is an extremely interesting field of research with a plethora of different applications.

During the last few years, the laboratory of Nanosensors at the URV has been developing novel technology for the development of carbon nanotube based potentiometric sensors. We have pioneered this field by showing the intrinsic role played by carbon nanotubes when acting as ion-to-electron signal transducers. Through the use of carbon nanotubes we have been able to develop a plethora of novel sensors that can detect inorganic and organic species, as well as biological compounds and even living bacteria. These sensors do not only show great versatility, but also improved response time, signal stability and roughness.

All these characteristics suggest that this technology will be ideal to build miniaturized sensors to detect substances in the micro and sub micro scale. This step has not been taken yet.

Aim of the work

This work aims to take the current carbon nanotubes sensor technology to develop micro sensors that can be used as detectors of microfluidic devices as well as sensors for living organisms. First, we will study the different ways in which the CNT-membrane electrodes can be constructed. After that, analytical characterization and optimization of the system will be performed. Then, we will work on development of miniaturized electrode arrays that can detect targets of biological relevance. Finally, we will apply these sensors to real systems, in order to test whether we can achieve optimal spatial resolution.

Candidate profile

This work has a very strong experimental bias. Therefore, it is expected that the ideal candidate is a hands on, self motivated person, with curiosity and willingness to explore, and skills and ability for building experimental systems. Proficiency in chemistry is essential, and basic knowledge on electronics (or willingness to learn it) will be an advantage.

Recommended reading

1. J. Wang, *Analytical Electrochemistry*, Willey-VCH, 3rd ed.
2. Cynthia G. Zosky, *Handbook of electrochemistry*, Elsevier
3. G. Crespo, *Solid Contact Ion Selective Electrodes Based on Carbon Nanotubes, Doctoral Thesis*, University Rovira i Virgili, Tarragona, **2010**
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5. Crespo, G. A. Macho, S.; Rius, F. X. Analytical Chemistry. 2008, 80, 1316-1322.
6. Zelada-Guillén, G. A. Bhosale, S. V. Riu, J.; Rius, F. X. Analytical Chemistry. 2010, 82, 9254-9260.
7. Carlini, W. G.; Ransom, B. R., Fabrication and Implementation of Ion-Selective Microelectrodes, Neuromethods, 1991, Volume 14, 227-320, DOI: 10.1385/0-89603-160-8:227 227-319.
8. Lindner, E.; Umezawa, Y. Performance evaluation criteria for preparation and measurement of macro- and microfabricated ion-selective electrodes (IUPAC Technical Report) *Pure and Applied Chemistry*. **2008**, *80*, 85-104.