Using the dynamic response of nanosensors to build autonomous analytical devices

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Background and state of the art

The use of nano-structured materials to improve the performance and expand the field of applications of chemical sensors has been a prolific and very successful area of research during the last decade. An example of this trend is the recent incorporation of carbon nanotubes (CNT) in solid-state potentiometric sensors. In this case, it has been shown that the CNT act as very efficient ion-to-electron transducers, improving the stability, response time and range of applications of the sensors. Furthermore, we have recently demonstrated that this CNT potentiometric sensing strategy is a way to develop flexible platforms that can be used out of the lab as diagnostic tools, wearable sensing devices, etc.

Despite of these significant improvements, nanosensors share with conventional chemical sensors many problems to overcome. One of them is detection and correction of interferences. Also, the need for calibration, a process that is usually tedious and that requires human intervention, fluid handling, etc. Finding ways to overcome these challenges is extremely important to take full advantage of these sensors.

One way that shows potential to solve many of these issues is the use of a flow injection approach. Flow injection (FI) techniques have shown the ability to improve the speed of the analysis and reduce sample manipulation and consumption. Above all, since the measurement is performed under dynamic flow conditions, FI is a simple way to introduce kinetics into chemical analysis. The possibility of incorporating the time domain as a variable is certainly extremely attractive that has shown in the past to be a powerful way to boost the performance of analytical systems.

Little is yet known, however, about the dynamic response of the potentiometric nanosensors. In the works that we have recently begun, we have found –for example- that these sensors show an very fast response time, which contradicts what was usually assumed about potentiometric sensors. These first works have opened an interesting avenue towards the development of fully autonomous devices, with potential to detect and correct interferences, perform self calibration, etc. These systems would be ideal tools for remote environmental monitoring, telemedicine, process control, etc.

Aim of the work

This work aims to explore and exploit the dynamic response of the carbon nanotubes-based ion-selective potentiometric sensors in chemical analysis. First, characteristic time-response pattern of the electrodes for the targets and the interferences will be studied. The results of these studies will be used in the design and optimization of fully autonomous analytical strategies.

Candidate profile

The work has a very strong experimental bias. The ideal candidate should be a hands-on, self motivated student with ability and willingness to explore new systems. Building and crafting lab tools –electrodes, cells, etc- will be part of the current work. Also, proficiency with basic data analysis tools is required. A basic knowledge of electronics –or willingness to acquire it- will be desirable.

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. Jaromir Ruzicka , Elo H. Hansen, *Flow Injection Analysis*, 2nd Edition, Wiley-Interscience
8. Marek Trojanowicz, *Flow Injection Analysis: Instrumentation and Applications*, World Scientific Pub Co Inc (June 2000)