Development of an Autonomous Sensing Device - detector based on miniature, solid-state ion-selective sensors

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Simple construction, good detection limit, very low power demand, and simple experimental setup coupled with miniaturization opportunities arising from solid-state format makes ISEs an excellent prospect for integration in autonomous sensing devices and ultimately their integration in large wireless chemo-sensing networks.[1, 2] The goal of our work is connected with preparation of ion-sensor prototypes suitable for this future application. We are focused on the fabrication of all-solid-state ISEs by varying conductive polymer materials and preparation of ISEs selective for a range of important species.

Among the different solid-contact materials able to convert the ion-exchange process occurring at the ion-selective membrane/sample interface into an electronic signal, electroactive conducting polymers (CP) are the most commonly used, due to their ability to generate a high redox capacitance that confers a high stability to the voltage recorded. Although conducting polymers have certain advantages with respect to other trancducing materials, they also display some drawbacks such as their intrinsic chemical instability under certain conditions, the possible formation of water layer at the interface with the polymeric ion-selective membrane, or the possibility of redox side-reactions with O_2 or change in the pH due to the diffused CO_2. The presence of a water layer at the inner membrane interface allows the establishment of membrane fluxes which influence the stability of signals at solid-contact electrodes and adversely affects the detection limit. If water is formed between the solid support and the conductive polymer layers, strong drifts are observed when electrodes are immersed in the solution of interfering ions.

In attempt to overcome these difficulties we will compare the properties (selectivity, sensitivity, lifetime), detection limit[4] of miniaturized solid-state ISEs prepared using different types of conductive polymers, including drop casting of POT, electropolymerization of pyrrole in the presence of potassium hexacyanoferrate (II)/(III)[3] or using new nanostructured materials such as 3-D ordered macroporous carbon[5] or single-walled carbon nanotubes[6] all deposited on screen-printed electrodes.

Our ultimate goal is prepare ISEs suitable for use as a chemo-sensing component in a widely distributed wireless sensor network (WSN) for monitoring the quality of a fresh water system, together with advanced diagnostics to evaluate the on-going functionality of the sensors using a simple electronic signal.

References:

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