Influence of real-life conditions on response of miniature, all-solid-state ion-selective sensors used as a detector in autonomous, deployable sensing device

Salzitsa Anastasova[1], Aleksandar Radu[1], Conor Slater[1], Beata Paczosa-Bator[2], Bartlomiej Wierzba[2], Jerzy Jasielec[3], Johan Bobacka[3*], Andrzej Lewenstam[3*], Dermot Diamond[1*]

[1]Adaptive Sensors Group, National Centre for Sensor Research, School of Chemical Sciences, Dublin City University, Dublin 9, Ireland
[2] University of Science and Technology, AGH, 30-059 Krakow, Poland
[3]Abo Academi, Tuomiokirkontori 3, FI-20500, Turku, Finland

j.bobacka@abo.fi
alewenst@abo.fi
dermot.diamond@dcu.ie

Electrochemical impedance spectroscopy (EIS) is a powerful tool for the analysis of various electrochemical systems because it allows the separation and characterization of individual kinetic processes. In this paper we describe our work on monitoring the condition of solid-state ISE membranes to determine whether they are ideally functioning, physically damaged, biofouled, have lost components (ionic sites, ionophore, plastisizer) through leaching, or whether there is an internal interfacial water layer present; all using EIS as a diagnostic tool. The theoretical treatment of EIS is typically based upon the Nernst-Planck flux equations coupled to Poisson's equation (NPP). We demonstrate experimental evidence of which parameters influence the response of ISEs – amount of ionic sites, thickness of membranes, diffusion coefficient in the membrane (different ratio PVC:plasticizer), dielectric constant (different plasticizer), presence of water layer (absence of conductive polymer between membrane and solid support) and use this data to model the response using NPP for prediction of response of ISEs.

The other avenue of our work is connected with comparing the properties and detection limit of miniaturized solid-state ISEs using different types of conductive polymers as POT or electropololymerization of pyrrole in the presence of potassium hexacyanoferrate (II)/(III).

More investigations will answer to what extent we can evaluate the functionality (damaged, fouled, components leached out – "good" or "bad") of these sensors using a simple electric signal. This will be a vital tool for probing the condition of remotely deployed ISEs in widely distributed chemo-sensor networks (e.g. for environmental monitoring) and for enhancing the reliability of these devices, and thereby simplifying the way in which they are used. [1,2,3] Our ultimate goal is to implement such tools so that ISEs can be deployed for weeks or months with minimal calibration or maintenance (ideally none or only at intervals detected by the sensor condition monitoring tools).

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