Electrochemical impedance spectroscopy as a tool for probing the functionality of ion-selective membranes

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Recent success in lowering of the detection limit of ion-selective electrodes (ISEs) to part-per-billion levels have opened up the possibility for their application in environmental analysis. Its simplicity, low cost, and low power requirement coupled with excellent selectivity and sensitivity make ISEs excellent detecting system in autonomous and deployable sensing devices for routine analysis and as early warning systems.

However, the necessity for calibration of detecting systems implies the use of sometimes complicated and costly systems for calibration solution and waste handling, pumps and data acquisition including the labour for system maintenance. Reducing the need for sensor calibration (or its complete elimination) would not only simplify sensing devices and reduce their costs but would allow integration of chemical sensors into the emerging area of wireless sensing networks (WSNs). It is envisioned that this integration will bring new dimensions into chemical sensing and bring benefits in many aspects of human lives.[1, 2]

Here, we describe our attempts to address the issue of reducing the need for sensor calibration. The functionality of a typical physical transducer is probed using electrical signals testing its resistance, impedance, conductance etc. We employ a similar strategy and apply relatively simple AC signals to an ion-selective membrane in order to probe its functionality after it has been subjected to conditions that simulate *in-situ* long-term deployments. For example, we observe the impedance spectra of membranes that have been physically damaged, biofouled and/or have components leached out. Comparing this information with the sensor's potentiometric behaviour, we can draw conclusions regarding the functionality of the devices and their suitability to continue serving as a reliable detectors, for example, in remote locations.

Literature

(1) Diamond, D.; *Anal. Chem.,* **2004**, *76*, 278A-286A.
(2) Diamond, D.; Coyle, S.; Scarmagnani, S.; Hayes, J.; *Chem. Rev.,* **2008**, *108*, 652-679.