Probing the functionality of ion-selective membranes using electrochemical impedance spectroscopy: Towards “calibrationless” sensors

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The vision of widely deployed wireless chemical sensing networks (WCSNs),depends on the availability of simple, low cost, low power chemical sensors. Due to their simple construction, yet excellent selectivity and sensitivity, ion-selective electrodes (ISEs) are excellent candidates for integration into such devices. Typical parameters used in characterisation of ISEs are slope, baseline, selectivity, limit of detection and the calibration is used to check these parameters and decide whether one or more of these parameters has crossed an “unacceptable” threshold, and the device is no longer reliable.

Unfortunately, current designs of autonomous, deployable chemical sensing devices necessary include pumps, valves, and containers for calibration solutions and waste storage, whichraises the costs of such devices to levels that render their integration into WCSNs impossible.In contrast, physical transducers like thermistors are typically subjected to a range of electrical tests to assess their functionality by probing their resistance, impedance, conductance etc.

The question we ask here is whether such tests can provide enough information to profile a chemical sensor’s functionality without having to employ reference solutions. For example, AC impendancecan give an insight into whether the bulk or interfacial characteristics have changed significantly due to physical damage, leaching of the membrane components or due to poisoning of the interface by biofoulingas well as by sample components.We show here initial results that suggest such tests enable the state of a chemical sensor to be profiled to some extent*without* liquid handling.