Electrochemical Control of Solid-Contact Ion-Selective Electrodes

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Abstract
Elimination of the internal filling solution of polymer membrane-based conventional ion-selective electrodes (ISEs) in 1971 initially aimed at producing miniaturized, inexpensive and robust ion sensors [1]. Gradually, the importance of the ion-to-electron transduction process at the interface between the ionically conducting ion-selective membrane and the electronically conducting electrode substrate was realized [2]. Over the years, various ion-to-electron transducers, including conducting polymers, nanostructured carbon materials and other functional nanomaterials, have been explored to improve the analytical performance of solid-contact ion-selective electrodes (SC-ISEs) [3-5]. Extensive research in our group has resulted in new methods to electrochemically control the response behaviour of SC-ISEs using poly(3,4-ethylenedioxythiophene) (PEDOT) as the ion-to-electron transducer [6]. By utilizing the electrochemical properties of PEDOT it is possible to control and reset the standard potential of SC-ISEs [7, 8]. Furthermore, the redox (pseudo)capacitance of PEDOT can be used to convert a potentiometric signal into a coulometric one for SC-ISEs [9-15]. This latter coulometric transduction method allows amplification of the analytical response of SC-ISEs [9-12], resulting in improved precision compared to classical potentiometry [13]. The coulometric transduction method has been evaluated for determination of various cations and anions by SC-ISEs [14, 15]. Furthermore, Bakker's group has shown that the coulometric method can be used to detect very small pH changes, down to 0.001 pH units [16], and it also provides a route towards self-powered ion sensors [17].

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