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ORIGINAL PAPER

Preparation of a miniaturised iodide ion selective sensor using polypyrrole and pencil lead: effect of double-coating, electropolymerisation time, and current density

[a]Mehrdad Gholami*, [b]Abdol-Majid Ghasemi, [b]Mohammad M. Loghavi, [a]Shima Behkami, [b]Amaneh Ahamdi-Dokht-Faraghe

[a] *Department of Chemistry, Marvdasht Branch, Islamic Azad University, P.O. Box 465, Marvdasht, Iran*

[b] *Engineering Institute of Agriculture Ministry, Fars Engineering Research Center (FERC), P.O. Box 71555414, Shiraz, Iran*

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Polypyrrole (PPy) is a conducting polymer which can be used for producing different ion-selective electrodes. An iodide-doped (PPy-iodide) was prepared electrochemically by anodic polymerisation of pyrrole in the presence of an iodide ion in an aqueous solution on the surface of a pencil lead. Polymerisation was investigated under galvanostatic conditions. The effects of electropolymerisation conditions on the characteristics of the potential response of the sensor were examined. Concentrations of pyrrole, iodide ions, and conditioning solution plus current density and the time of electropolymerisation were optimised in relation to the slope and linearity of calibration graphs. This electrode showed a Nernstian behaviour of 61.1 mV per decade for I^- ion over a wide concentration range from 1.0×10^{-5} M to 1.0×10^{-1} M, with the limit of detection of 9.3×10^{-6} M. The response time of the electrode was from 3–5 s. The selectivity coefficients of the prepared sensors over a wide spectrum of interference anions were also evaluated, revealing that selectivity improves as a result of double-coating with PPy. A similar improvement was observed under lower current density and longer electropolymerisation time. This sensor was applied in the determination of iodide ions using titration potentiometry. This electrode can be used for the determination of iodide in drug preparations.

Keywords: ion selective electrodes, polypyrrole, conducting polymers, iodide anion, sensor

Introduction

Polypyrrole (PPy) is a conducting polymer which can be used as a conductive electrode material (Omastová & Mičušík, 2012; Albano & Sevilla, 2007; Şahin et al., 2008, 2009; Shafiee-Dastjerdi & Alizadeh, 2004; Zanganeh & Amini, 2007; Bendikov et al., 2005; Aravamudhan & Bhansali, 2008; García Alonso et al., 1999; Maksymiuk et al., 2000; Ge et al., 1992; Shin & Kim, 1995).

The generally accepted mechanism for electropolymerisation has the following steps: (i) oxidation of pyrrole molecule and generation of a radical cation; (ii) dimerisation of two radical cations; (iii) oxidation of the dimer; (iv) interaction of radical cation with a monomeric radical cation to afford a trimer and, ultimately, polymer (Bradner & Shapiro, 1988; Diaz & Lacroix, 1988; Skotheim, 1986).

The polyradical cation so produced attracts anions into the polymerised film as counter or dopant ions. Besides the positive charge, the polymer forms a host cavity suitable for a given dopant anion. The possible interference by other ions can be restricted by adjusting the steric effect which is produced by the host cavity (Jovanovic et al., 1997).

The electrochemical approach for making PPy con-

*Corresponding author, e-mail: m.gholami@miau.ac.ir