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ORIGINAL PAPER

Polyaniline doped with poly(acrylamidomethylpropanesulphonic acid): electrochemical behaviour and conductive properties in neutral solutions

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Poly(2-acrylamido-2-methyl-1-propanesulphonic acid) (PAMPSA)-doped polyaniline (PANI) layers are synthesised in the presence of sulphuric and perchloric acids. The effects of the inorganic acid as well as of the electrochemical synthetic procedure (potentiostatic and potentiodynamic deposition) and thickness of the polymer layers are studied. The focus is directed towards the pH dependence of the electrochemical redox activity and conductivity of the PAMPSA-doped PANI layers obtained under different conditions. Ascorbic acid oxidation is used as a test reaction to study the electrocatalytic behaviour of various PAMPSA-doped PANI layers in neutral solution. It is found that the type of inorganic component present in the polymerisation solution has a marked effect on the extent of doping in acidic solutions as well as on the redox electroactivity in neutral solutions. A comparison between potentiostatically and potentiodynamically synthesised layers at pH 7 shows a markedly lower conductance and lower extent of redox charge preservation in the case of potentiodynamic synthesis. The PANI electrocatalytic activity for ascorbic acid oxidation is also dependent on the polymer electrodeposition procedure, with potentiostatically synthesised layers exhibiting better electrocatalytic performance.
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Introduction

Polyaniline (PANI) is one of the most intensively studied and widely used conducting polymers (Inzelt, 2008; Eftekhari, 2010). It is readily obtained by chemical or electrochemical polymerisation in aqueous solutions, which represents an important advantage over other types of conducting polymers, e.g. polythiophenes. However, a major disadvantage of PANI is its pH-dependent electroactivity and conductivity, which restricts its applications to acidic solutions.

PANI may take various oxidation states (leucoemeraldine, emeraldine, and pernigraniline salts and bases) and has a complex pH-dependent chemistry (Inzelt, 2008; Eftekhari, 2010). In the emeraldine salt state, which is usually stable only in acidic solutions, PANI exhibits high electrical conductivity. At pH values beyond pH 3, conventional PANI becomes deprotonated and loses its electroactivity and conductivity. Two main approaches have been used to overcome this problem: the use of self-doped (i.e. sulphonated) PANI (Yue et al., 1991; Yue & Epstein, 1990, 1992; Karyakin et al., 1994, 1996; Wei et al., 1996) or the use of non-releasable dopants based on polyanions (e.g. polysulphonic) (Hyodo et al., 1988, 1991a, 1991b; Łapkowski, 1993; Ding & Park, 2003). In both cases, in slightly

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