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Electro-catalyzed oxidation of reduced glutathione and 2-mercaptoethanol by cobalt phthalocyanine-containing screen printed graphite electrodes

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Abstract

Electro-catalytic behavior of screen printed graphite electrodes modified with cobalt phthalocyanine (CoPc) towards the oxidation of reduced glutathione (GSH) and 2-mercaptoethanol (2-ME) is reported. We find, by using cyclic voltammetry, that the oxidation of 2-ME occurs at 0.2 V vs Ag/AgCl and −0.3 vs Ag/AgCl V at pH=7 and pH=13, respectively and that of GSH occurs at 0.4 V vs Ag/AgCl and 0.0 V vs Ag/AgCl at pH=7 and 13, respectively. The electro-catalytic activity depends on the method of electrode modification and the amount of catalyst incorporated in the ink used to fabricate the SPCEs. The highest activity was obtained with electrodes prepared with 2.5% (w:w) of CoPc.

Keywords: Screen printed carbon electrodes; Cobalt phthalocyanine; Reduced glutathione; 2-mercaptoethanol

1. Introduction

Thiols are sulphur containing amino acids that build proteins and are essential in the formation and growth of tissues [1,2]. They are also involved in marking of food deterioration, oil processing and are found as industrial waste products [3,4]. Their detection has been a subject of research in the last decade to the benefit of both the industrial and biological worlds. Thiols such as reduced glutathione (GSH) and 2-mercaptoethanol (2-ME) have been detected by various methods including high-performance liquid chromatography (HPLC) [5], spectrofluorimetry [6], spectrophotometry [7] and potentiometry [8]. The above-mentioned methods afford thiol detection with high sensitivity and selectivity i.e. without interferences, but they are unsuitable in cases where rapid and accurate measurements are needed as they often require extraction and pre-concentration steps.

Electrochemical methods have been employed with great success for thiol detection [8,9]. The only shortcomings encountered were slow rates of electron transfer on electrode surfaces and application of large overpotential. These were however counteracted by chemically modifying electrode surfaces. Metallophthalocyanines (MPcs) have been used as catalysts towards thiol electro-oxidation in acidic and alkaline solutions, increasing rates of electron transfer as well as reducing applied overpotentials [10,11]. Electrodes modified by adsorption or electro-deposition of cobalt phthalocyanine and its derivatives have been reported to be excellent catalysts towards electro-oxidation of *L*-cysteine, 2-ME and reduced GSH [12–15].

The search for stable MPc complexes that afford thiol detection at low overpotentials, high current densities and faster electron transfer rates continues. For application in various conditions, electrodes have to be miniaturized in some cases to enable facile maneuvering. Also, their methods of preparation should be amendable to mass production and performed at low cost with high reproducibility. Screen printed electrode devices offer these advantages. Indeed, they are disposable hence eliminate the extra, tiresome duty of cleaning/polishing. Moreover,

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