Electrocatalytic Oxidation of Guanine and DNA on Carbon Paste Electrode Modified by Cobalt Hexacyanoferrate Films

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We are living in an age where molecular genetics represents the new frontier [1]. The genetic information required for the function and multiplication of the biological organism is stored, duplicate and transformed by means of nucleic acids [2]. By the discovery of the electroactivity of deoxyribonucleic acids in 1960 [3] the interest of most researchers was to apply modern voltammetric methods in nucleic acid and DNA analysis [4]. Electrochemical DNA sensing is a promising technique of nucleic acid analysis because of its quickness, high sensitivity and low cost [5, 6].

The electrochemical analysis of nucleic acids based on their oxidation in aqueous solution at the surface of carbon paste electrode (CPE) has attracted considerable interest over the past two decade. In contrast to carbon paste electrodes that have been widely used for stripping analysis of nucleic acids, there are only few reports [7, 8] on the use of chemically modified CPE for enhancing the voltammetric response of DNA. In this report, the continuation of our previous study [8], we describe the application of cobalt hexacyanoferrate modified carbon paste electrode for electrocatalytic detection of DNA in aqueous solutions.

The electrochemical behavior of cobalt hexacyanoferrate complex adsorbed on carbon paste electrode is investigated. CoHCF films as shown in figure 1, were electrodeposited with cyclic voltammetry from 0.0 V to +1.1 V vs. Ag/AgCl at 100 mV s⁻¹ from a fresh solution mixture containing 0.5 M KCl, 1 mM Co(NO₃)₂ and 0.5 mM K₃Fe(CN)₆. After 15 cycles, CPE was taken out and rinsed thoroughly with water. The complex was adsorbed strongly on the surface of CPE. The shape and the potential of the surface peaks of the CoHCF are dependent on the choice of the cation of the supporting electrolyte [9]. For example, the voltammetric feature of such an electrode is substantially changed by passing from 0.5 M NaCl to 0.5 M KCl solution and appear a new reversible redox peak at Epc+ Epa/2=840mV vs. Ag/AgCl (Fig. 2). This new peak can play an important role in the electrocatalytic oxidation of guanine and ss-DNA as illustrated in figure 3. The modification of CPE by the adsorption of this complex results in excellent amplification of guanine oxidation response of ss-DNA. The electrocatalytic oxidation mechanism of nitrite ion was investigated by using cyclic voltammetry and hydrodynamic voltammetry methods. The effects of scan rate, DNA and guanine concentration were studied. Kinetic parameter such as α and kₐ were obtained in this study.

References: