

# Electrochemical investigation of glassy carbon paste electrode and its application for guanine and ssDNA detection

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## Abstract

A glassy carbon paste electrode (GCPE) is fabricated and investigated by studying the electrocatalytic behavior of ferrocyanide redox couple on its surface by using cyclic voltammetry (CV). The GCPE showed voltammetric responses with high sensitivity and low background compared with both glassy and graphite carbon electrodes. It also showed a distinct oxidation peak at +0.9V after preconcentration of guanine at +0.5V for 1.0 min in pH 4.3 acetate buffer solution (0.1M). This paper also reports the use of square wave voltammetry (SWV) for monitoring guanine. A linear dynamic range of 0.5 to 50 µg/ml for guanine is obtained with  $R^2 = 0.995$ , the intra-day precision RSD = 1.90% (n = 7) and inter-day precision RSD = 2.98% (n = 6). A detection limit of 50 ng/ml was obtained. The SWV studies using the GCPE showed two well-resolved peaks for guanine and adenine in ssDNA at +1.05 and +1.30V respectively, revealing the applicability of the GCPE for electrochemical detection of ssDNA. A linear range of 1.0 - 10.0 µg/ml with the detection limit 100 ng/ml,  $R^2 = 0.993$  for guanine and 0.992 for adenine was obtained. The inexpensive and easy to prepare GCPE offers a high electrochemical activity and a relatively low background current.

**Keywords:** Cyclic voltammetry; Square wave voltammetry; Glassy carbon paste electrode; Guanine; ssDNA

## 1. Introduction

In electroanalysis, various carbon electrodes are widely used due to their low background current, wide potential window, chemical inertness, low-cost, and suitability for various sensing and detection applications [1]. Glassy carbon electrodes (GCE) have been used owing to their renewability and easy surface modification [2, 3]. The ability of glassy carbon paste electrodes (GCPE) to be used for lead, cadmium, zinc and copper detection was demonstrated [4]. Also, GCPE have been utilized for differential pulse voltammetric detection of uric acid in the presence of ascorbic acid and acetaminophen [5], voltammetric determination of tryptophan and serotonin [6], differential pulse voltammetric determination of N,N-dimethyl-4-amino-4'-hydroxyazobenzene [7], amperometric detection of thymol [8], linear scan voltammetry (LSV), differential pulse voltammetry (DPV), and voltammetric determination of carcinogenic 1-nitropyrene and 1-aminopyrene [9]. Detection of elevated levels of nucleic acids could be indicative of certain disease [10, 11]. Wang et al. reported well-developed oxidation peaks for DNA and RNA at electrochemically pretreated carbon paste electrodes [12]. Potentiometric and

adsorptive stripping voltammetric detection of single-stranded DNA at electrochemically modified glassy carbon electrode was demonstrated [13,14]. Voltammetric determination of guanine and guanosine at different electrodes was investigated [15-20].

To the best of our knowledge, there is no study has been yet reported on the electrochemical determination of guanine and/or ssDNA on the electrochemically pretreated glassy carbon paste electrode surfaces. This work demonstrates the fabrication and investigation of the GCPE, and its application for guanine and ssDNA detection. In order to design an electrochemical sensing interface with high sensitivity and renewability, electrochemical treatment was utilized to improve the electrochemical responses of the GCPE. In this paper the capability of GCPE to be used for detection of guanine and ssDNA is proven and reported in the following sections.

## 2. Experimental

### 2.1. Apparatus

Cyclic and square wave voltammetry experiments were carried out using an electrochemical work station (CHI1140A, CH