

CARBON-BASED ELECTRODES MODIFIED WITH PEROVSKITE MATERIALS

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Introduction

Due to its diversity, performance, high oxidation–reduction characteristics, voltammetric / amperometric detection of biomolecules, electrical conductivity and electrocatalytic activity, perovskite oxides have received increasing attention. In addition, some perovskite materials are demanding because they help to improve electrode performance. Perovskite materials are used in the electrochemical detection of alcohols, glucose, hydrogen peroxide, gases and even emerging pollutants. The purpose of this research study was to characterize and to test modified electrode materials obtained from two commercial carbon based electrodes and two perovskite materials. Commercial boron-doped-diamond modified with LaCoO_3 ($\text{LaCoO}_3/\text{BDD}$) and glassy carbon modified with CdCr_2O_4 ($\text{CdCr}_2\text{O}_4/\text{GC}$) were tested for the detection of docetaxel (DCT) and sodium diclofenac (DCF) in water, which were chosen as target emerging pollutants.

Materials and methods

The electrochemical experiments were performed using an Autolab Potentiostat / Galvanostat PGStat 302 (EcoChimie, The Netherlands) controlled with GPES 4.9 software and three-electrode cell with saturated calomel electrode as reference (SCE), platinum electrode as counter-electrode and working electrode ($\text{CdCr}_2\text{O}_4/\text{GC}$ and $\text{LaCoO}_3/\text{BDD}$). The supporting electrolyte of 0.1 M NaOH solution was prepared using NaOH of analytical purity and distilled water. Cyclic voltammetry (CV) was the electrochemical technique applied for electrochemical characterization and analytical applications.

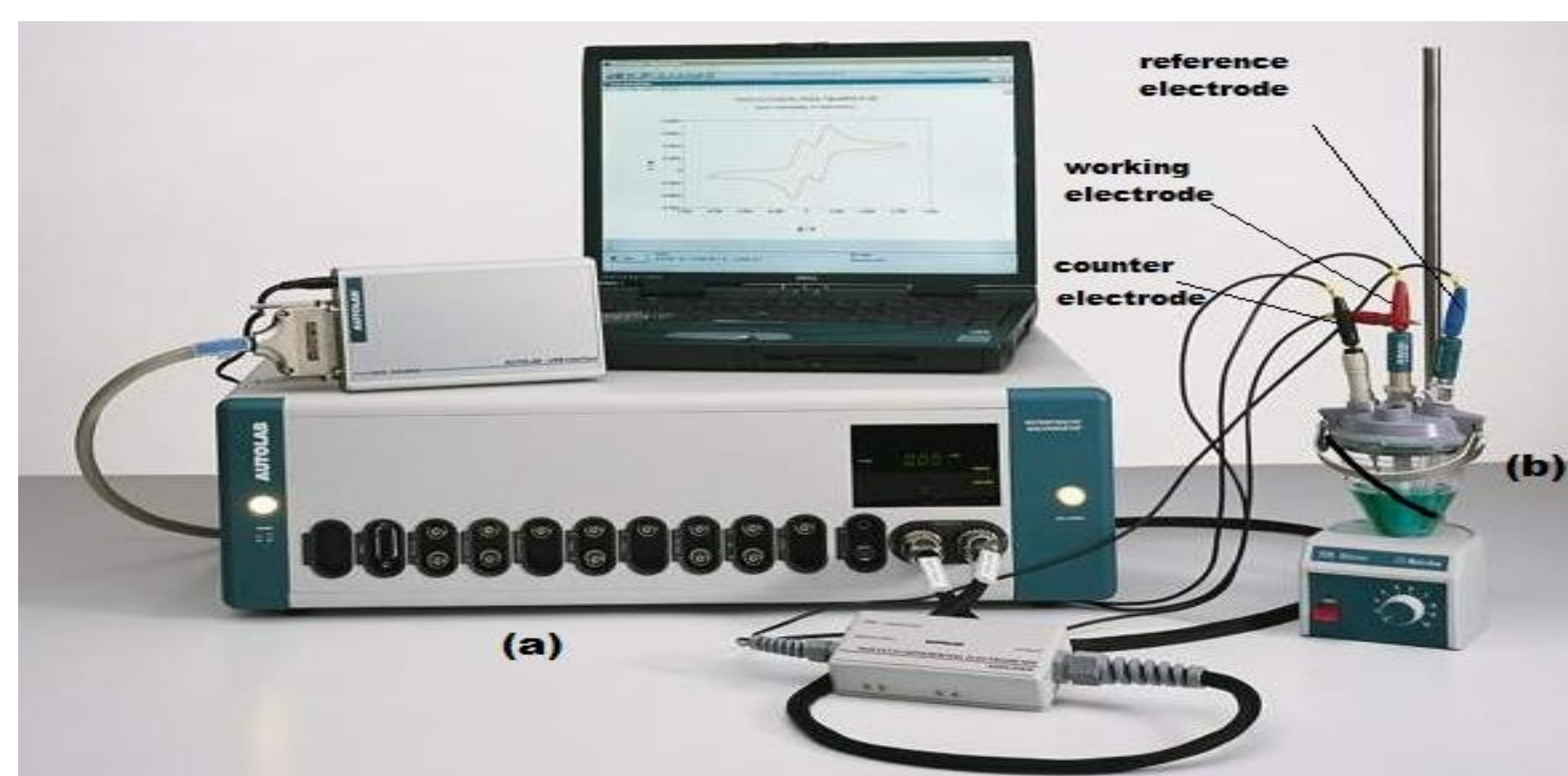


Fig.1 a) The image of a potentiostat/galvanostat, type PGSTAT 302, Eco Chemie

Fig.1 b) Metrohm three-electrodes cell

Results

The first stage of this study was to modify the commercial glassy carbon (GC) and boron-doped-diamond (BDD) electrodes through simple immersion for 15 seconds in a 5 mg/ml concentration suspension of CdCr_2O_4 respective LaCoO_3 . For the characterization of the two perovskite materials, the new electrodes obtained ($\text{CdCr}_2\text{O}_4/\text{GC}$ and $\text{LaCoO}_3/\text{BDD}$) were tested in the electrochemical detection of diclofenac and docetaxel. The $\text{CdCr}_2\text{O}_4/\text{GC}$ electrode allowed DCF detection of two electrochemical potentials of 1.1V/SCE and 1.35V/SCE (Figure 2a). In the case of the $\text{LaCoO}_3/\text{BDD}$ electrode, the electrochemical detection of DCT occurred at the potentials of 0.14 V/SCE and 0.27V/SCE (Figure 3a). At the 1.1 V potential, the lowest sensitivity ($4.96 \mu\text{A}\mu\text{M}^{-1}\text{cm}^{-2}$) was obtained by testing the $\text{CdCr}_2\text{O}_4/\text{GC}$ electrode for DCT detection (Figure 2b) and the best sensitivity ($174.7 \mu\text{A}\mu\text{M}^{-1}\text{cm}^{-2}$) was obtained in the case of DCF detection using the $\text{LaCoO}_3/\text{BDD}$ electrode at the potential of 0.27V/SCE (Figure 3b).

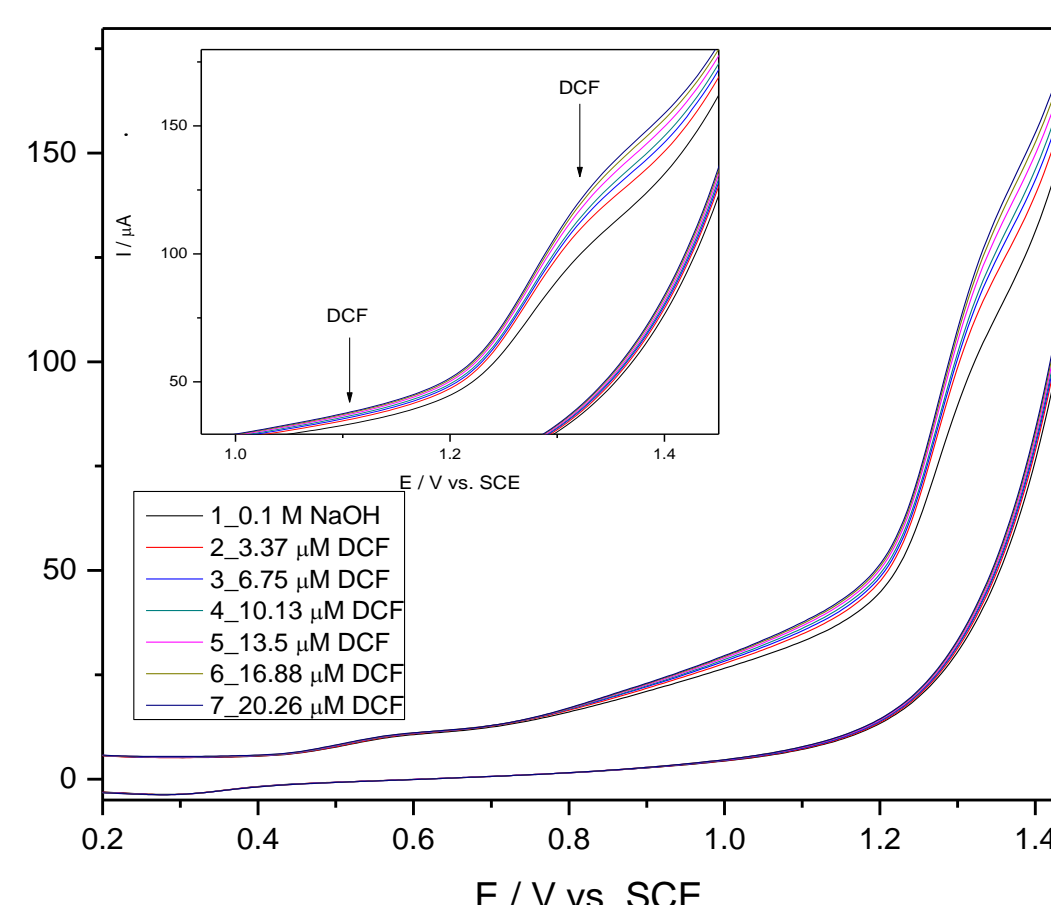


Figure 2a. Cyclic voltammograms recorded at the $\text{CdCr}_2\text{O}_4/\text{GC}$ electrode in 0.1 M NaOH and in the presence of 3.37-20.3 μM DCF.

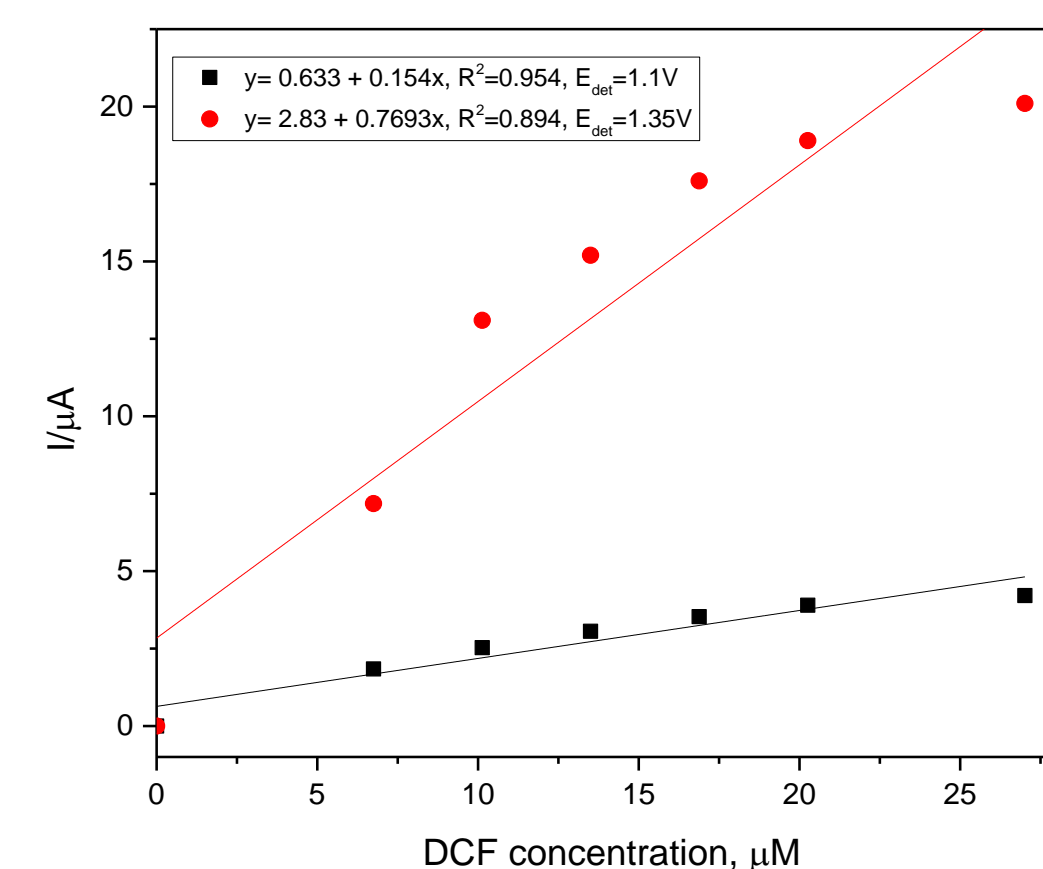


Figure 2b. Calibration plots of the currents recorded at $E_1 = 1.1\text{V/SCE}$ and $E_2 = 1.35\text{V/SCE}$ versus DCF concentrations.

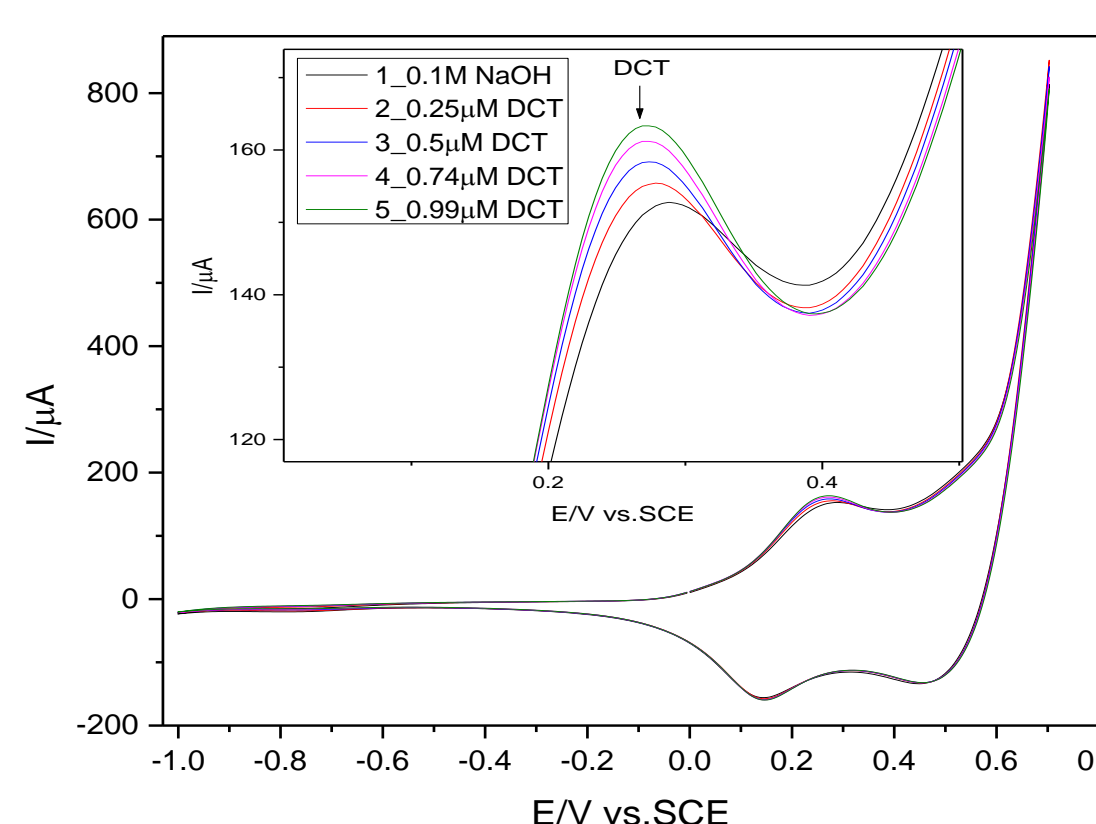


Figure 3a. Cyclic voltammograms recorded at the $\text{LaCoO}_3/\text{BDD}$ electrode in 0.1 M NaOH and in the presence of 0.25-0.99 μM DCT.

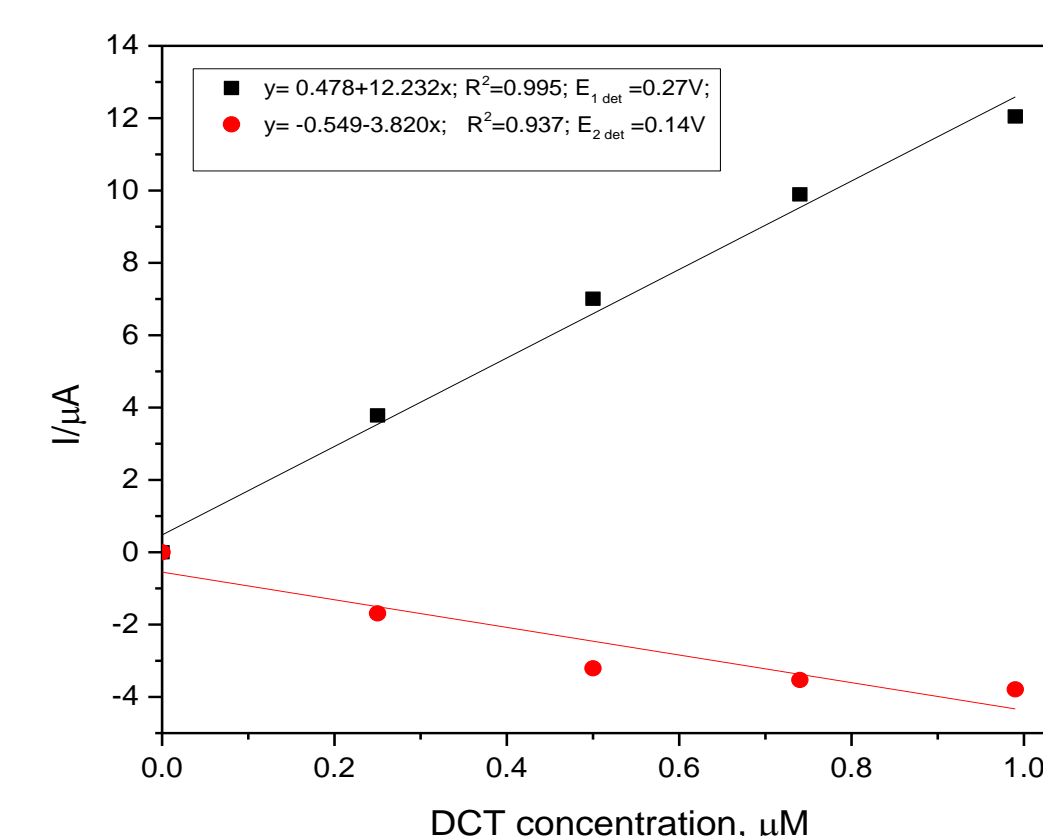


Figure 3b. Calibration plots of the currents recorded at $E_1 = 0.27\text{V/SCE}$ and $E_2 = 0.14\text{V/SCE}$ versus DCT concentrations.

Conclusions

Based on the results of this study it can be concluded that boron-doped-diamond modified with LaCoO_3 ($\text{LaCoO}_3/\text{BDD}$) and glassy carbon modified with CdCr_2O_4 ($\text{CdCr}_2\text{O}_4/\text{GC}$) electrodes are appropriate for the electrochemical detection of docetaxel respective sodium diclofenac in water.

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