

A Thesis for the Degree of Ph.D. in Science

Simple Electrochemical Detection Methods of
Metabolites and Drug with Bare BDD Electrodes

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Thesis Abstract

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Thesis Title Simple Electrochemical Detection Methods of Metabolites and Drug with Bare BDD Electrodes			
<u>Thesis Summary</u> This thesis uses the simple electrochemical redox method to measure metabolites and drugs in human biofluids for sustainable biosensing techniques. In particular, based on boron-doped diamond (BDD) with excellent sensitivity, durability, and resistance to non-specific adsorption, target-selective determination methods have been developed. Chapter 1 introduces the background and purpose of this study. Chapter 2 describes the study of urinary NaNO_2 selective determination on a bare BDD electrode. Without adding other reagents for measurement, such as enzymes, the measurement uses a simple electrochemical approach with an oxidation step followed by reduction. This work focuses on the reduction potential range for the detection. It is different from many previous literature reports on the oxidation reaction. Spiked NaNO_2 was determined by cyclic voltammetry and differential pulse voltammetry within two pooled and three individual urine samples. We found that the linear response ranges for sodium nitrite detection were 0.5–10 mg/L and 10–400 mg/L and obtained the calibration curve, with the limit of detection (LOD) being clinically relevant. Chapter 3 describes the selective detection of urinary creatinine (CRE) on a bare BDD electrode. A similar strategy of electrochemical oxidation followed by reduction is employed. This measurement consists of continuous electrochemical redox of CRE with added reagents of Cl^- and NaNO_2. Concentration dependence of CRE in the range of 100–2500 mg/L and 0–25 mg/L is fulfilled successfully. We tested CRE measurements in two pooled urine and six individual urine samples diluted with D-PBS with 30 mg/L NaNO_2 added. The calculated CRE results have good agreement with those obtained from the Jaffé method. This strategy may potentially detect urinary creatinine, which might be clinically valuable. Chapter 4 describes the edoxaban (EDX) determination on a bare BDD electrode. In this method, no other reagents are added. EDX is detected by using a similar oxidation followed by a reduction strategy. The study discusses the different electrochemical redox states of EDX on the BDD electrode. The reduction peak for the determination of EDX can be observed only after the electrochemical oxidation process. In PBS, EDX shows a good linearity with the LOD smaller than other electrodes. The same procedure measures EDX in human plasma, and the concentration dependence indicates this method has the feasibility of EDX determination on bare BDD. Chapter 5 summarizes the results of this study and provides the future perspective.			