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Molecularly Imprinted Polymers for the Selective Detection of Multi-Analyte Neurotransmitters

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Abstract

This paper reports on the development of electrochemical sensors for the detection of multiple neurotransmitters using molecularly imprinted polymers (MIPs). Pyrrole (PPy) and o-phenylenediamine (o-PD) were used as functional monomers for the MIP sensor development, and the characteristics of those sensors were analyzed. Specifically, we demonstrate a selective detection of dopamine (DA), norepinephrine (NE), and epinephrine (EP) by applying differential pulse voltammetry (DPV) to each uniquely developed MIP-based sensor. Furthermore, the selectivity of the analyte was quantified based on the sensitivity matrix. Our results demonstrate that all MIP sensors possessed higher sensitivity than non-imprinted (NIP) sensors due to the unique molecular receptors. The detection limits of the developed MIP sensors were less than 1.3×10^{-5} M. The uniqueness of the cross-reactivity in the DA-imprinted and EP-imprinted sensors demonstrate the possibility of implementing a multi-analyte sensing platform that can detect multiple neurotransmitters simultaneously from a single sample solution.

1. Introduction

Neurotransmitters are chemical messengers produced in the brain that plays an important role in human's physical, psychological and emotional conditions. The balance of neurotransmitters can affect the brain function, mood, pain response and exercise performances. In particular, dopamine (DA), norepinephrine (NE), and epinephrine (EP) are three well-known neurotransmitters that control various functions in the nervous system [1–3]. The lack of dopamine may cause serious diseases such as Parkinson's Disease [4], and low level of norepinephrine in blood may lead to hypotension. Epinephrine, on the other hand, is a potent vasopressor drug widely used [5]. EP is also used to treat severe anaphylaxis [6] by using an epinephrine autoinjector to directly administer EP to the affected muscle [7]. Epipen is a wildly used epinephrine autoinjector for millions of people in recent years. The price for a two-pack Epipen has increased from $100 in 2009 to $600 today, which causes a current national conversation. Therefore, the detection of DA, NE and EP are extremely important for many instances of mental disease treatment and diagnosis. One of the most promising sensing techniques for neurotransmitter monitoring is the electrochemical detection method because of its high sensitivity, relatively low-cost and ease of operation [8],[9]. However, in the *in vivo* detection scenario where many types of neurotransmitters would be present in the sample, the