生体液中ストレスバイオマーカーの電気化学的検出に向けた酸化還元プローブ内包分子鋳型高分子膜の創製

Development of Molecularly Imprinted Polymer intrinsically doped with Redox Probe for Electrochemical Determination of Stress Biomarkers in Biological Fluids

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1. Introduction

Cortisol is an important stress biomarker. Timely diagnosis of chronic stress can assist in prevention of various health problems. Molecularly imprinted polymer (MIP)-based biosensors allow for fast and point-of-care detection and can be produced economically. The imprinted sites in the MIP function as highly selective binding sites, mimicking the functioning of enzymes [1].

This study discusses the fabrication of Polypyrrole (PPy) MIP intrinsically doped with hexacyanoferrate (HCF) redox probe for label-free quantitative measurement of cortisol in biological fluids such as saliva. β-cyclodextrin (CD) is also leveraged to improve the imprinting of the polymer.

2. Experiments

Polished glassy carbon electrode (GCE) was coated with 10 µL of 0.1 mg mL^{-1} graphene oxide (GO) to fabricate GO/GCE. CD was electrodeposited on the GO/GCE by performing cyclic voltammetry (CV) with simultaneous reduction of GO to obtain CD-rGO/GCE. HCF doped-PPy MIP was electrochemically deposited on CD-GO/GCE using CV in presence of $K_3[Fe(CN)_6]$ redox probe and cortisol template. The template was then extracted from the polymer matrix by overoxidation using CV to obtain PPy-HCF/CD-rGO/GCE MIP. A non-imprinted polymer (NIP) was also fabricated as control using similar method but without introducing template.

CV was used for cortisol detection using phosphate buffer saline (PBS) at pH 7.4 containing a fixed amount of cortisol as the electrolyte. Prior to measurements, prepared sensors were allowed to incubate in the electrolyte for 10 min.

3. Results and Discussion

The cyclic voltammograms of prepared MIP with different concentrations of cortisol (5 pg mL^{-1} – 5000 ng mL^{-1}) incubated on the electrode were compared (Fig. 1a). The peak current around 0.2 V corresponding to intrinsic HCF redox probe was observed to be decreasing with increasing cortisol concentration in case of MIP. The imprinted PPy has cortisol specific sites which can be occupied by the target analyte. As the analyte concentration increases, more sites are occupied, which increases the charge transfer impedance for HCF redox process, manifesting as reduction in peak currents. NIP exhibit marginal change in current because it does not contain such specific imprinted sites (Fig. 1b) [2,3].

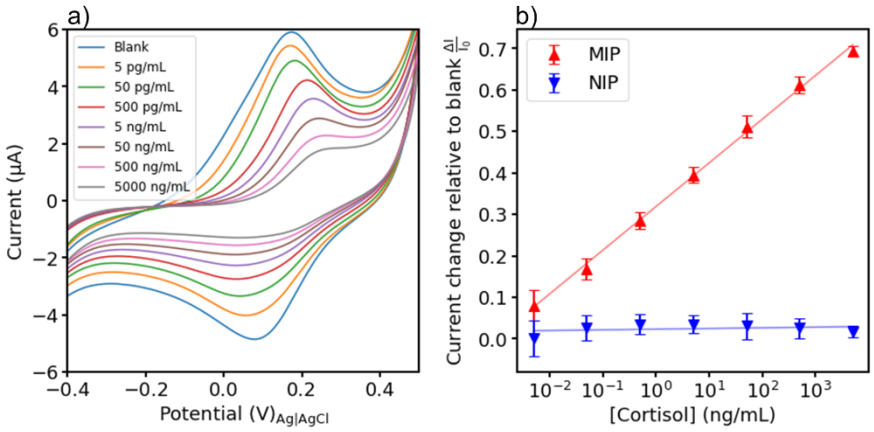

Fig. 1 (a) CV of MIP for different cortisol concentrations (b) Sensor response for MIP and NIP

References

[1] T. Sakata et al., *RSC Advances*, 2020, *10*, 16999.
[2] A. Goyal, T. Sakata, *ACS Omega*, 2022, *7*, 33491-33499.
[3] S. Yeasmin et al., *Biosens. Bioelectron.*, 2022, *206*, 114142

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