Molecularly Imprinted Polymer-Decorated Ruthenium Oxide Electrode for Rapid Electrochemical Detection of Clinically Relevant Proteins

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The use of molecularly imprinted polymers (MIPs) as biomimetic receptors in sensing devices presents a promising strategy to overcome the limitations of biological recognition elements, such as instability under thermal and pH variations and limited shelf life. Molecular imprinting creates specific cavities within a polymeric network that mimic the size, conformation, and chemical properties of target molecules, enabling high specificity and efficient binding. Integrating MIPs with electrochemical transducers offers a powerful approach for developing portable sensors with real-time monitoring capabilities, user-friendliness, low cost, and high sensitivity [1]. A direct sensing strategy that eliminates the need for external redox probes further enhances sensor performance by better mimicking complex sample environments and reducing interpretation errors.

Ruthenium oxide (RuO_2) electrodes, known for their excellent electrochemical properties, have received limited attention in molecular imprinting applications. Here I present a study conducted by my research group demonstrating the synergy between a MIP layer and a RuO_2 electrode in an electrochemical sensor designed for the direct detection of disease biomarkers in biological samples. In this sensor configuration, RuO_2 functions both as the electrode transducer and as an integrated redox probe, enabling signal measurement directly in the analyte solution [2,3]. Protein biomarkers, including brain-derived neurotrophic factor (BDNF) and growth factor X, were selected as target analytes. Following optimization of template elution, rebinding time, and MIP layer thickness, the sensors exhibited effective performance within relevant analytical ranges in serum samples. Furthermore, the sensors demonstrated high reusability, maintaining consistent performance across multiple rebinding–regeneration cycles.

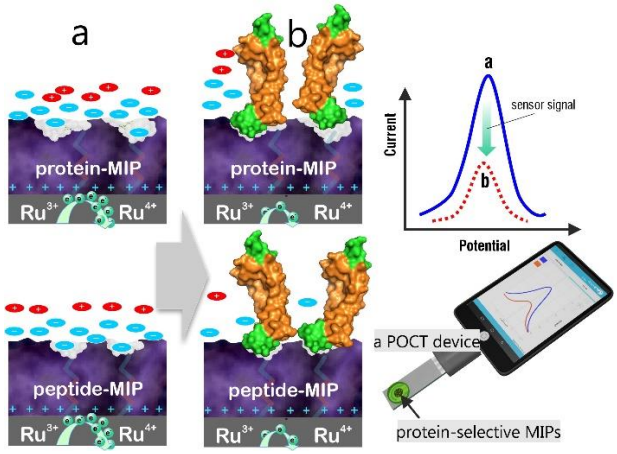

Figure 1: Schematic representation of the principle of protein detection using a MIP-decorated ruthenium oxide electrode.

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References

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