ELECTROCHEMICAL SENSORS BASED ON MOLECULARLY IMPRINTED POLYMERS FOR DETECTION OF SMALL MOLECULES

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Molecularly imprinted polymers (MIPs) are synthetic polymeric materials prepared via polymerisation in the presence of a template molecule, resulting in selective recognition sites complementary in shape, size, and functional groups. Often described as “plastic antibodies”, MIPs mimic the molecular recognition behaviour of natural antibodies while offering high selectivity and binding affinity [1]. Compared to biological receptors, MIPs exhibit enhanced chemical and thermal stability, greater resistance to harsh environmental conditions, and lower production costs. Consequently, they have been widely used to detect low-molecular-weight analytes, including food contaminants, pharmaceutical compounds, and environmental pollutants [2,3]. MIP fabrication typically involves self-assembly of functional monomers with the template, chemical or electrochemical polymerisation to form a rigid polymer matrix, and subsequent template removal to generate selective binding cavities [3].

In this work, electrochemical sensors employing polypyrrole-based molecularly imprinted polymers (MIPs) were developed for the selective detection of low-molecular-weight analytes, including melamine [2] and salicylic acid. The MIPs were synthesised via electropolymerisation of a pre-polymeric solution comprising pyrrole as the functional monomer and the corresponding template molecules. The resulting polymer films were amperometrically deposited directly on graphite and screen-printed carbon electrodes. After polymerisation, the template molecules were removed, generating specific recognition sites within the polymer matrix. For comparison, non-imprinted polymer (NIP) electrodes were fabricated under identical conditions, in the absence of the template molecules.

The electrochemical properties of all polypyrrole films were characterised using cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS). Interactions between the template molecules and the polymer layers were evaluated by comparing oxidation peak currents measured via differential pulse voltammetry (DPV). The obtained results, together with the calculated apparent imprinting factors, indicate that the fabricated MIPs are well suited for developing electrochemical sensors to detect low-molecular-weight analytes.

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Keywords: molecularly imprinted polymer (MIP); polypyrrole (Ppy); conducting polymers; electrochemical sensor.

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