Design and experimental verification of molecular imprinted polymers based molecular recognition elements

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ABSTRACT

In the field of chemical sensors, the increased demand for enhanced sensitivity, faster response, and higher selectivity require the development of more and more efficient molecular recognition units or sensing layers. Thus, the development of suitable functional molecular recognition elements is the heart of sensor fabrication. With this context and with the aim to detect melamine (MA) adulterant molecule in milk, we designed and fabricated molecularly imprinted conducting polymer (MICP) chemical sensor based on hydrogen bond donor/acceptor principle, and development of molecular recognition units for the preparation of electrochemical sensors. The pre-polymerization complex formation between the template and different functional monomers (aniline-ANI, itaconic acid-IA and acrylic acid-AA) was studied by Fourier transform infrared (FTIR) spectroscopy before the actual polymerization that simplified the sensor fabrication processes. It was observed that the interactions/stability of the monomer-template complex increases from the MA-aniline complex (MA-ANI) to the MA-ANI-acrylic acid complex (MA-ANI-AA) and then to MA-aniline-itaconic acid complex (MA-ANI-IA) based on the intensity of the FTIR absorbance. Starting from the electrolyte solutions containing MA as a template molecule in the presence of ANI and its mixtures (ANI-IA and ANI-AA) as functional monomers, homo, and heteropolymers based MICP films were electrosynthesized onto the glassy carbon electrode (GCE) and used for MA electrochemical detection. The final performance of the films was evaluated based on the electrochemical measurements depending on the strength of the MA-functional monomers interactions in the pre-polymerization medium. This interaction greatly influences the microstructure of the polymer matrices and its final performances. The fabrication method developed gives pure products and the novel MIP recognition materials prepared in this thesis provide the benefits of the uniform binding properties of synthesized MICP thin films, resulting from affinity-based recognition on the surface of the polymer matrices. The copolymerization approach is proposed to be the best approach for the electrode surface modification and successfully improved the physicochemical properties of PANI to recognize MA. We believe the developed MIP thin films might be used in food quality monitoring applications and, in the future, possibly in online applications in the food industries and government authorities. Furthermore, the integration of the developed recognition materials into other transduction mechanisms is highly recommended for further benefits.