Electropolymerized Molecularly Imprinted Polymer (E-MIP) Sensors

Rigoberto C. Advincula
Case Western Reserve University
Department of Macromolecular Science and Engineering
2100 Adelbert Rd.
Cleveland, OH USA 44106

Molecularly Imprinted Polymers (MIP) has been utilized to prepare polymer materials and thin films used for sensors and separations process. Various methods have been used to prepare these polymers using vinylic and acrylate polymers. The typical preparation method involves monolith formation and the use of separate monomers and cross-linkers. A key step is the use of complexation and pre-monomer orientation prior to polymerization and crosslinking. While widely successful in separation methods even with commercial applications, their use for sensing is limited due to the poor performance and limited stability and reusability.

A good number of sensors rely on metal-electrode transduction either by electrochemical, optical, or frequency (acoustic) methods. Improve stability would allow for its use in various demanding applications with higher pH and temperature. Direct electropolymerization on surfaces is regarded as a most promising technique to interface the imprinted polymer layer on the surface of the transducer/electrode.

Polymers which exhibit pi-conjugation in its structure, commonly called conducting polymers, can be formed by the electropolymerization process due to the presence of electrochemically active sites for radical cation coupling of its monomers. In contrast to the traditional methods of bulk/solution polymerization employing free radical polymerization mechanisms which yield monoliths, thin, electropolymerized imprinted polymer films can be obtained via this process. Thin films are more useful in sensing applications as film thickness is one of the factors that can affect efficient detection. Transduction techniques that can be viably coupled to these electropolymerized films can be more commercially attractive.

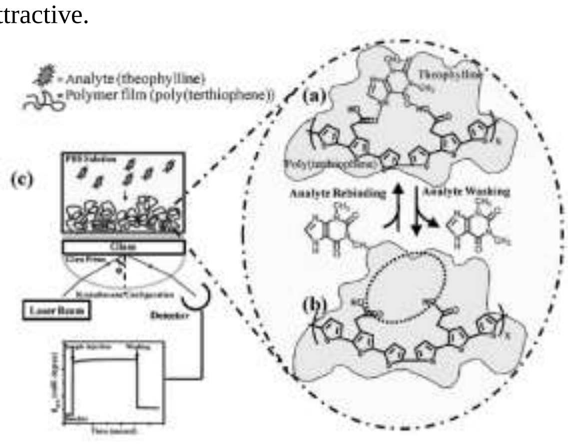

Fig. 1. Sensing of theophylline demonstrated via surface plasmon resonance spectroscopy (SPR): (a) Molecular imprinting of the template. (b) Formation of cavity after washing the template. (c) SPR setup for sensing of the template'

We have investigated a number of systems involving electropolymerized-molecularly imprinted polymers (E-MIP) for the sensing of theophylline, folic acid, etc. Highly improved sensitivity, selectivity, limit of detection, and dynamic range has been observed. We have used the formats of surface plasmon resonance spectroscopy (SPR) and quartz crystal microbalance (QCM) to demonstrate efficacy. These results will be reported.

References:

1. Pernites, R.; Ponnapati, R.; Felipe, J.; Advincula, R.* "Electropolymerization molecularly imprinted polymer (E-MIP) SPR sensing of drug molecules: pre-polymerization complexed terthiophene and carbazole electroactive monomers" Biosensors and Bioelectronics 2011, 26 (5), 2766-2771.

2. Apodaca, D.; Pernites, R.; Ponnapati, R.; Del Mundo, F.; Advincula, R. "Electropolymerized Molecularly Imprinted Polymer (E-MIP) Films of a Bis-Terthiophene Dendron: Folic Acid Quartz Crystal Microbalance Sensing" ACS Applied Materials and Interfaces 2011, 3 (2), 191-203.

3. Advincula, R. "Engineering Molecularly Imprinted Polymer (MIP) Materials: Developments and Challenges for Sensing and Separation Technologies" Kor. J. Chem. Eng. 2011, 28, (6), 1313-1321.