Molecular Imprinted Polymer-based Sensor

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Molecular Imprinted Polymers (MIP) are developed as sensitive and selective layers for the detection of melamine and nicotine in liquid solutions. The MIP layer can be deposited on different transducers, for example in this study on electrochemical electrodes (EC) for nicotine detection and on Quartz Micro Balance (QCM) for melamine detection. The results show that this technique is particularly adapted for the detection of analytes at rather low concentrations and, thanks to its high selectivity, to the differentiation of targeted molecules from molecular analogues.

The demand for highly specific and sensitive sensors is continuously increasing for the detection of targeted molecular compounds, such as pollutants, contaminants, toxic gases, biological markers. To this end, MIP is a promising approach as with this technique, the MIP detection layer can be specifically designed for being selective to the target analytes. For the formation of a MIP, a polymer layer composed of a monomer with a specific functional group is mixed with the target analytes during production. After reticulation, the target analytes is dissolved leaving cavities in the polymer layer with a specific shape, size and functionalities. The MIP layer becomes therefore highly and selectively sensitive when re-exposed to the target molecule.

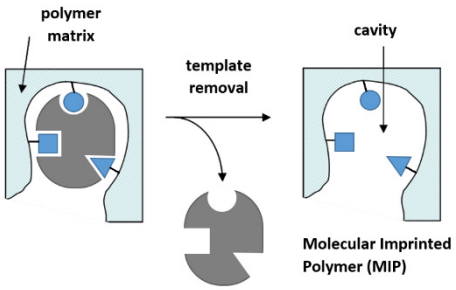

Figure 1: Principle of MIP detection.

For the production of MIP layers, the polymer monomer is mixed with a cross-linker, an initiator, the target molecule that serves as the porogen, and a common solvent. After solubilization, the MIP solution can be deposited by spin coating or by dispensing on the transducer substrate. Curing of the layer occurs then by thermal heating or by UV exposure. The cured MIP layer is finally washed with a solvent to remove the target molecule (porogen). In this study, two different MIP layers have been designed for respectively melamine and nicotine detection.

For signal reading, a large range of transducers can be adapted to the MIP layer, such as electrochemical (EC) electrode, optical systems, or quartz microbalance (QCM). In this study, QCM and EC transducers were used for nicotine detection and QCM was used for melamine detection.

For the detection of melamine, the MIP layer was deposited by spin coating on QCM. Figure 2 shows the results for different concentrations of melamine in solutions, from 0.1 g/L to 1 g/L. The curve with a smaller amplitude corresponds to the Non-Imprinted Polymer (NIP) as a reference. For the NIP, the same polymer layer was used without adding the template nicotine molecule.

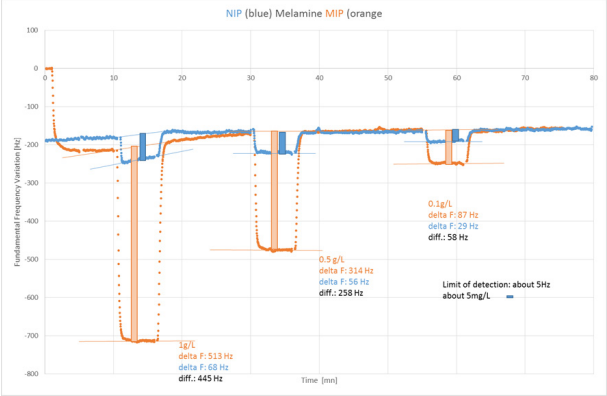

Figure 2: Melamine detection for a MIP deposited on QCM. The curve with the smaller amplitude corresponds to the NIP (Non-Imprinted Polymer).

For nicotine detection, the MIP was deposited on EC electrodes or on QCM by dispensing. The MIP on EC electrodes was particularly adapted to detect low level of nicotine in water solution, down to 1 ppm. An additional series of measurement on QCM showed the high selectivity of nicotine MIP by comparing the signal obtained with other molecules, as shown in Figure 3. In this figure, the measurement was done with anabasine solutions and nornicotine solutions, for which no signal could be observed, in contrast to the nicotine solution, which shows a strong response.

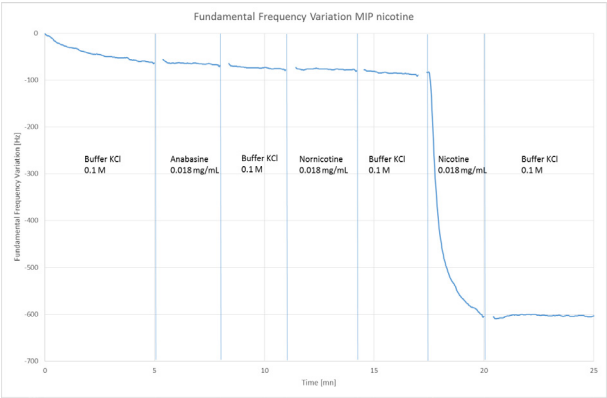

Figure 3: MIP detection of nicotine on QCM. Comparison with the signal obtained with anabasine and nornicotine.

In conclusion, MIP is a suitable approach for the specific detection of analytes with a high level of selectivity. It is not limited to the two cases used in this study, *i.e.*, melamine or nicotine, but can be extended to a wide range of other molecular compounds.

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