Molecularly Imprinted Polymers for the Capacitive Detection of Amphetamine-Type Stimulants

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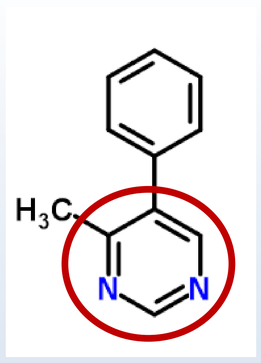
Introduction

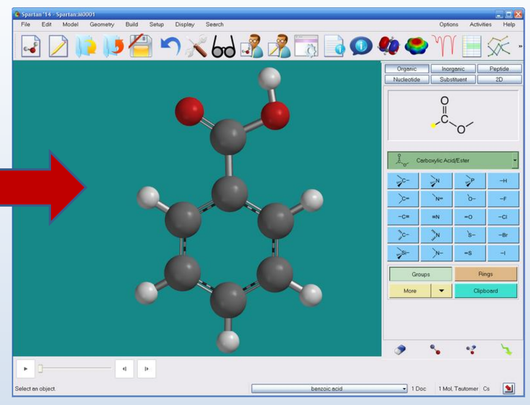
- Illicit drug use includes the non-medical use of a variety of drugs that are prohibited by international law.
- Detection of chemical markers related to the illegal synthesis of these drugs of abuse in sewage water is an approach to monitor the imperilment of the environment by chemical production waste.
- This work presents a capacitive biosensor for the detection of 4 methyl- 5 phenylpyrimidine (4M5PP) as an ATS-marker using molecularly imprinted polymers (MIP) as recognition elements.

Materials & Methods

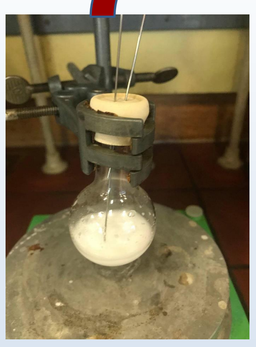


4M5PP

Pyrimidine was chosen as a template for MIPs synthesis

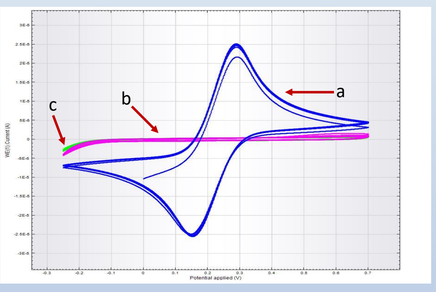


Computational design to select the best monomers

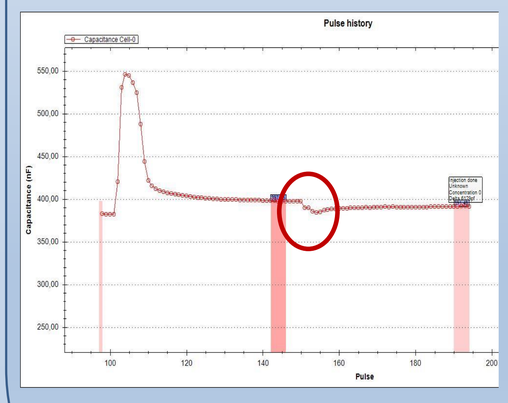


Emulsion polymerization for MIPs synthesis

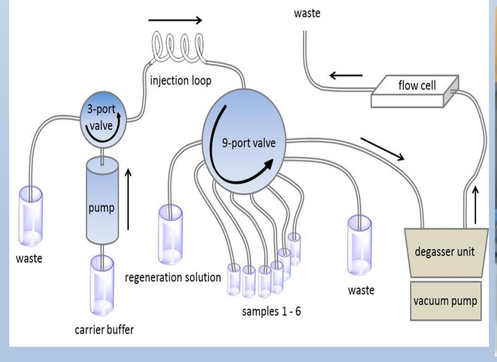
Obtained particles are functionalized on the gold electrode surface.



Comparison of electrodes insulation with the use of cyclic voltammetry.(a) bare; (b) modified with MIPs; (C) after treatment with 1-dodecanethiol.

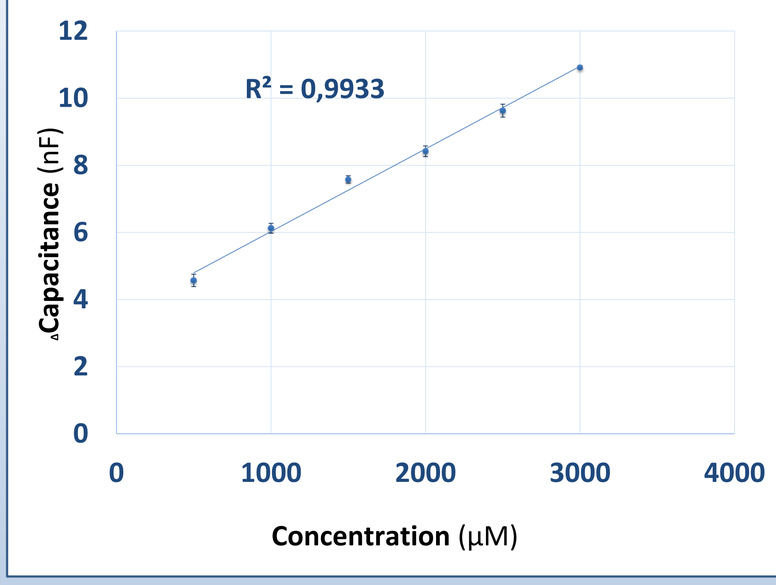


Drop in Capacitance value is measured

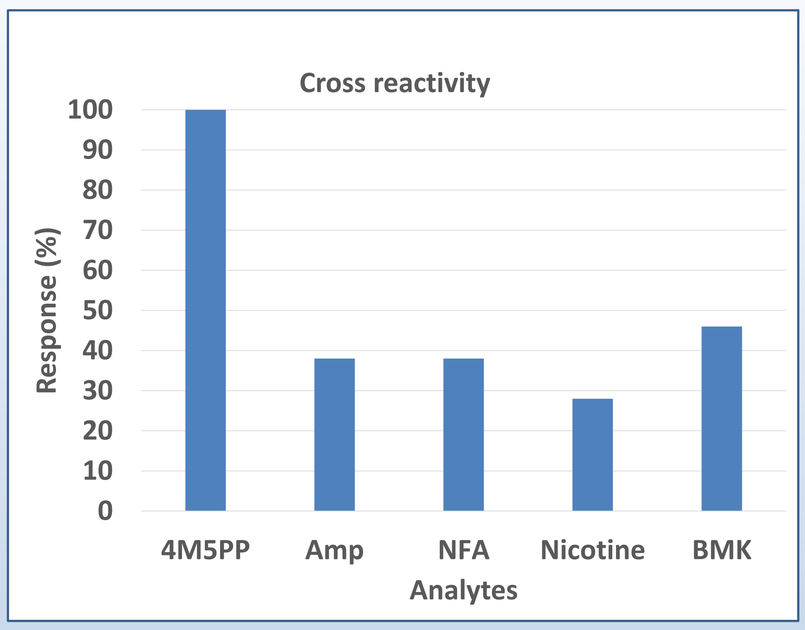


The measurements were done using a continuous flow system with a capacitive sensor resembling a continuous waterflow

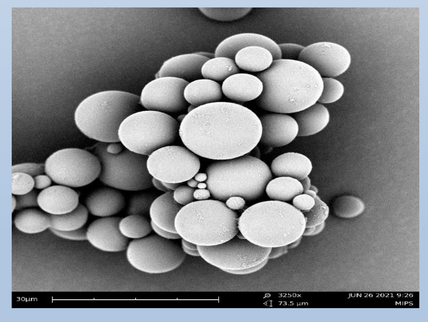
Results & Discussion

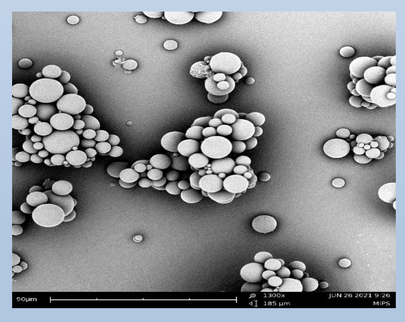


Change in capacitance (nF) of the MIP functionalized electrode as a function of concentration (µM). The limit of detection is 500 µM with a linear range of 500 µM – 3 mM. The sensor was tested in environmental water samples, and it showed the same results as in purified water.



Cross-reactivity experiments performed with four structural similar compounds.





Scanning Electron Microscopy (SEM) pictures of synthesized molecularly imprinted polymers (MIPs), MIPs for 4M5PP prepared using emulsion polymerization.

Effect of Additives:

The impact of different additives on the capacitive signal (detergents, shampoos, pharmaceuticals, and sweeteners) was tested. Pharmaceuticals and sweeteners showed a decrease in the capacitance drop. The major impact resulted from the detergents and shampoo, with 0.1% detergent and 0.1% shampoo giving false positive results.

Conclusion

1. The synthesized particles for 4M5PP showed high selectivity and significant sensitivity towards the target compound.
2. The limit of detection was 500 µM with a linear range of 500 µM – 3 mM.
3. The sensor could be used with real environmental water samples.

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