Next-generation sensing: towards a real application of the MIP-sensors based on Green Analytical Chemistry

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Green analytical chemistry (GAC) is a branch of modern analytical chemistry that focuses on minimizing the environmental impact of chemical processes. With the aim of reducing the use of hazardous reagents, limiting waste production and promoting energy-efficient processes, GAC is proposed as a solution to the growing demand for sustainable and eco-friendly approaches [1].

Chemical sensors based on molecularly imprinted polymers (MIPs) have proven to be tools that meet the requirements and principles of green analytical chemistry, opening new, more environmentally friendly and efficient pathways [2]. Designed to recognize specific target molecules, MIPs function similarly to natural receptors in biological systems. Their high selectivity, sensitivity and robustness therefore make them ideal candidates for applications in environmental monitoring, medicine and food safety. The advantages of MIP-based sensors include the use of electrochemical techniques where miniaturized transduction elements can be used, allowing limited use of reagents and solvents, with the possibility of regeneration approaches that reduce their overall environmental impact while enabling regular monitoring at lower cost and in the shortest possible time.

This presentation discusses the integration of MIP-based sensors with GAC principles and show some recently developed sensors [3 – 5] optimized for monitoring in complex matrices such as milk, tap water, seawater and surface water. By combining these tools with miniaturized devices, research is getting closer to the next generation of sensors, making monitoring of environmental pollutants, early diagnosis in hospitals and checking for adulterants in food a daily routine.

[1] de la Guardia, M., C Garrigues, S. (Eds.). (2012). *Handbook of green analytical chemistry* (Vol. 794). Chichester: John Wiley C Sons.

[2] Martins, R. O., Bernardo, R. A., Machado, L. S., Junior, A. C. B., Maciel, L. Í. L., de Aguiar, D. V. A., ... C Chaves, A. R. (2023). Greener molecularly imprinted polymers: Strategies and applications in separation and mass spectrometry methods. *TrAC Trends in Analytical Chemistry*, 117285.

[3] Costa, M., Di Masi, S., Garcia-Cruz, A., Piletsky, S. A., C Malitesta, C. (2023). Disposable electrochemical sensor based on ion imprinted polymeric receptor for Cd (II) ion monitoring in waters. *Sensors and Actuators B: Chemical*, *383*, 133559.

[4] Di Masi, S., Costa, M., Canfarotta, F., Guerreiro, A., Hartley, A., Piletsky, S. A., C Malitesta, C. (2024). An impedimetric sensor based on molecularly imprinted nanoparticles for the determination of trypsin in artificial matrices–towards point-of-care diagnostics. *Analytical Methods*, *1c*(5), 742-750.

[5] Costa, M., Di Masi, S., Zaleski, C., Piletsky, S. A., C Malitesta, C. (2023). Preliminary studies on the synthesis of redox-labelled molecularly imprinted nanoparticles in sensor development for the quantification of perfluoroalkyls in water. *Engineering Proceedings*, *35*(1), 22.