Development of Molecularly Imprinted Polymers by Advanced Technologies – E. Camilli

Abstract

Molecularly Imprinted Polymers (MIPs) as artificial receptors have received considerable scientific attention in the past few decades, as material for biomimetic molecular recognition. This thesis explores the fabrication of MIPs by Additive Manufacturing (AM), an emerging and largely unexplored field. Specifically, Digital Light Processing (DLP) technology was employed to fabricate 3D-printed, self-standing MIP structures with tailored geometries and functionalities.

The developed MIPs target environmental remediation applications, focusing on the selective removal of antibiotics from water. Oxytetracycline (OTC), a widely used antibiotic and common environmental contaminant, was chosen as the template molecule. The optimized MIP formulation also included Methacrylic Acid as the functional monomer, Dipropylene Glycol Diacrylate as the crosslinker, and Dimethyl Sulfoxide as the solvent. Density Functional Theory (DFT) calculations were used to model the interactions between the template and functional monomer, guiding the formulation development.

Experimental work revealed that 3D-printed MIPs exhibit promising selectivity and removal efficiency, influenced by factors such as geometry, surface area, and polymer composition. Additional investigations into micrometric porosity and reusability were conducted, though challenges in reproducibility and structural integrity highlighted areas for improvement. The results underscore the potential of 3D-printed MIPs as a platform for advanced environmental remediation and sensing solutions, while also identifying key challenges and opportunities for future research.

Beyond environmental remediation, the versatility of MIPs was further explored in electrochemical sensing applications. A side project investigated the electrodeposition of MIPs onto nanostructured gold electrodes, aiming to integrate them into electrochemical sensor platforms. The electrodeposited MIPs were tailored for the selective detection of OTC, demonstrating their potential in molecular recognition-based sensors.