Electrochemical Monitoring of Polystyrene Nanoplastics – Fungal Biomass Interactions for Advanced Sensing Applications

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Nanoplastics in environment

Nanoplastics (NPs) are emerging pollutants of concern due to their persistence, mobility, and ability to penetrate biological systems, posing risks to aquatic ecosystems and human health. Their small size and complex interactions in water make detection challenging, often requiring advanced instrumentation. In this work, we present a novel approach combining the removal of polystyrene nanoplastics (PSNPs) using Trametes versicolor (TRVE) biomass with electrochemical monitoring to evaluate adsorption in real time under different operational conditions.

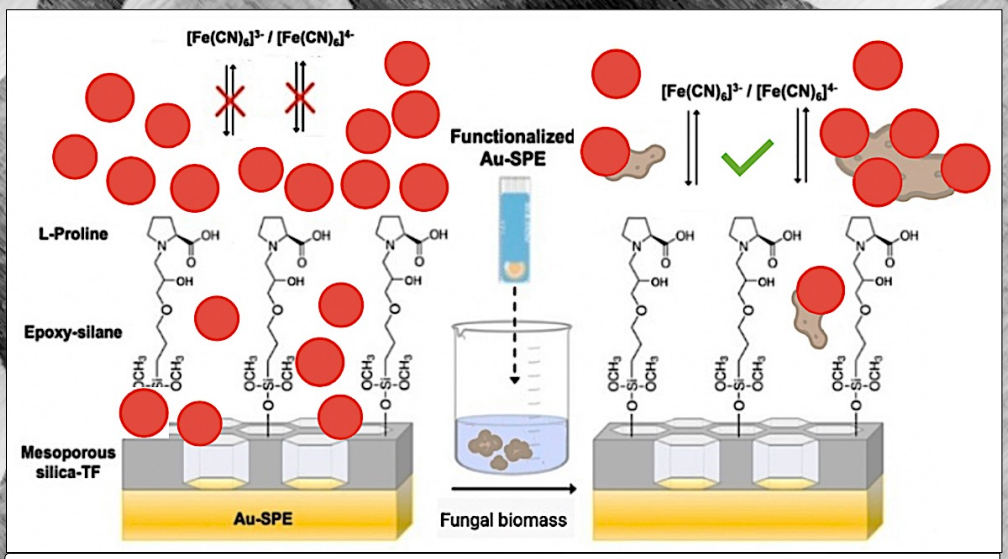

Fig. 1 PSNPs detection via pore blocking on functionalized Au-SPE and their removal by fungal biomass, preserving the electrochemical signal.

Sensor preparation

The sensor is based on Au screen-printed electrode (SPE) modified with mesoporous silica thin film by electro-assisted deposition, followed by functionalization with epoxy-silane and L-Proline [3,4]. Detection relies on PSNP binding to amino groups and electrostatic attraction under positive potential. The optimal accumulation potential was +0.6 V, determined in 5 mM HCF by cyclic voltammetry (CV).

Detection of nanoplastics

L-Proline captures PSNPs through binding to surface-immobilized amino groups and electrostatic attraction under positive potential. The adsorbed particles create a blocking layer over the electrode, limiting access of the $[Fe(CN)_6]^{3-}/[Fe(CN)_6]^{4-}$ probe to the active surface. When TRVE biomass was added, no pore blockade occurred, indicating nearly complete removal of PSNPs from the solution.

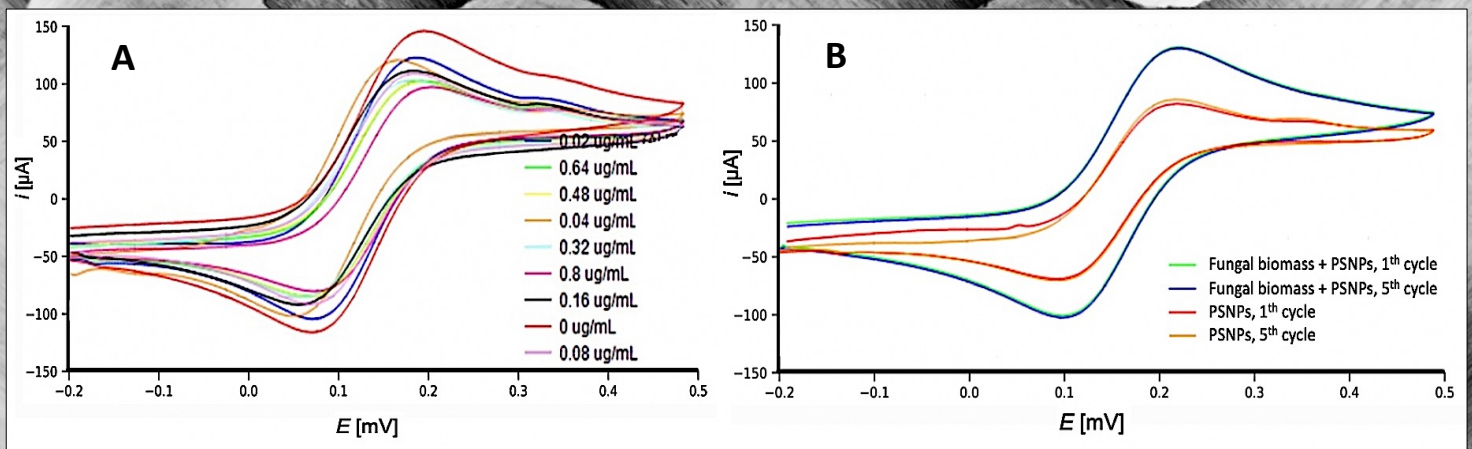

Fig. 2 A) CV for the 1th cycle during measurements with the addition of different concentrations of PSNPs; B) CV for the 1th and 5th cycle for measurements with and without the addition of fungal biomass in a solution containing PSNPs.

Fig. 3 Nanoplastics pollution in ocean.

Results & Conclusion

A calibration curve for 6.1 nm PSNPs (0.02–0.8 µg/mL) showed a **15–35% decrease in i_{pa}** observed by cyclic voltammogram (CV). Peak current decrease was proportional to PSNP concentration. Addition of 0.05 mg TRVE biomass to 0.8 µg/L PSNP suspension caused **no i_{pa} decrease, indicating near-complete adsorption** and removal. The sensor enabled real-time monitoring without biomass interference. This study demonstrates a portable electrochemical sensor for on-site detection of PSNPs and their sustainable removal from aquatic environments.

References

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