Cutting Edge Conference 2025

AT THE CROSSROADS OF THREE REALMS

15.09.2025

FACULTY OF CHEMISTRY AND
CHEMICAL TECHNOLOGY, LJUBLJANA

www.cutting-edge.si

BOOK OF ABSTRACTS:
Cutting Edge – AT THE CROSSROAD OF THREE REALMS

Organizator in založnik zbornika:
Fakulteta za kemijo in kemijsko tehnologijo, Univerza v Ljubljani

Kraj dogodka:
Fakulteta za kemijo in kemijsko tehnologijo, Univerza v Ljubljani

Uredniki:
Jure Jakoš, Klara Klemenčič, Ines Babnik

Oblikovanje in prelom:
Jure Jakoš, Klara Klemenčič

Organizacisjki odbor:
Ines Babnik, Jure Jakoš, Klara Klemenčič

Publikacija je izšla v elektronski obliki in je dostopna na spletnem naslovu:
http://www.cutting-edge.si/wp-content/uploads/2025/09/CE-BoA-2025.pdf

Ljubljana, Slovenija, 2025

Kataložni zapis o publikaciji (CIP) pripravili v Narodni in univerzitetni knjižnici v Ljubljani
COBISS.SI-ID **248110083**
ISBN 978-961-7078-60-2 (PDF)

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

Tia Kralj*,[1] Andrej Gregori,[2,3] Gregor Marolt,[1]

[1] Faculty of Chemistry and Chemical Technology, University of Ljubljana, Večna pot 113, *SI*-1000 Ljubljana, Slovenia
[2] Biotechnical Faculty, University of Ljubljana, Jamnikarjeva 101, *SI*-1000 Ljubljana, Slovenia
[3] MycoMedica Ltd, Podkoren 72, *SI*-4280 Kranjska Gora, Slovenia

Nanoplastics (NPs), ultrafine synthetic polymer particles, are emerging as a concerning class of pollutants due to their high mobility, persistence, and ability to penetrate biological membranes and accumulate within aquatic ecosystems[1]. Their nanoscale dimensions (< 1 µm) and intricate interactions in water make their detection challenging, often requiring complex analytical procedures and sophisticated instrumentation techniques. Their small size facilitates uptake by organisms and integration into food webs, raising concerns over ecological and human health impacts[2]. In this work, we present a novel, integrated approach to i) remove polystyrene nanoplastics (PSNPs) from water using fungal biomass and ii) electrochemically monitor PSNPs for the evaluation of their adsorption onto the biomass surface. The mycosorption on a medicinal fungus *Trametes versicolor* (TV) particles was systematically evaluated under various operational parameters. Its effectiveness as a sustainable and efficient biosorbent was monitored and confirmed with the electrochemical sensor, based on a gold screen-printed electrode (Au-SPE), modified with a mesoporous silica thin film via electro-assisted deposition and subsequently functionalized with epoxy silane and proline[3,4], designed to interact selectively with PSNPs. The sensing process is driven by two key factors: the binding of PSNPs onto immobilized amino acid groups, and the application of a positive potential that promotes electrostatic interaction between the negatively charged PSNPs (in 0.1 M KCl) and the working electrode. The modification steps were systematically tracked and characterized via cyclic voltammetry (CV). The optimal accumulation potential was found at +0.6 V, producing the largest current decrease. All measurements were performed in 5 mM HCF, serving as a redox probe. The sensor was employed to detect 6.1 nm PSNPs based on the decrease of the anodic current peak (i_{pa}), consistent with their ability to penetrate the mesoporous film. In this regard, a calibration curve for 6.1 nm PSNP was constructed in the range of 0.02–0.8 µg/mL, resulting in 15–35% decrease in i_{pa}, demonstrating the sensor's sensitivity and applicability for quantitative analysis. When 0.05 mg of TV biomass was introduced into 5.0 mL of 0.8 µg/L PSNPs suspensions, no decrease in i_{pa} was observed, confirming a nearly-complete adsorption and thus removal of PSNPs from solution. This process was observed in real time by the sensor without any interferences of TV biomass particles, as confirmed by additional control experiments using CV. This study presents a portable electrochemical sensor for real-time detection of PSNPs and their adsorption onto TV biomass, offering a sustainable approach for on-site monitoring and mitigation of NPs pollution in aquatic environments.

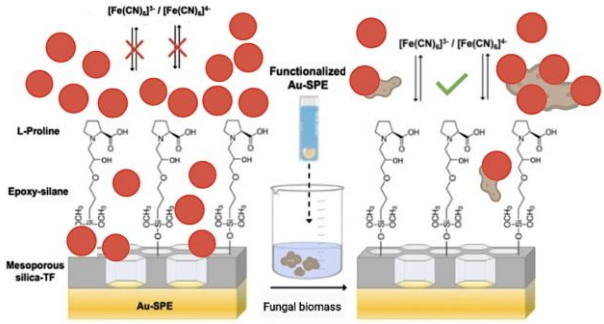

Figure 1: PSNPs detection via pore blocking on functionalized Au-SPE and their removal by fungal biomass, preserving the electrochemical signal.

References:

1. Sana, S. S.; Dogiparthi, L. K.; Gangadhar, L.; Chakravorty, A.; Abhishek, N. Effects of microplastics and nanoplastics on marine environment and human health. *Environ. Sci. Pollut. Res.* **2020**, *27* (36), 44743–44756.
2. Zhang, B.; Chao, J.; Chen, L.; Liu, L.; Yang, X.; Wang, Q. Research progress of nanoplastics in freshwater. *Sci. of The Tot. Environ.* **2021**, *757*, 143791.
3. Walcarius, A. Electrochem. applic. of silica-based materials. *Chem. Mater.* **2001**, *13* (10), 3351–3372
4. Fernández, I.; Sánchez, A.; Díez, P.; Martínez-Ruiz, P.; Di Pierro, P.; Porta R.; Villalonga, R.; Pingarrón, J. M. Nanochannel-based electrochemical assay for transglutaminase activity. *Chem. Communic*. **2014**, *50*, 13356–13358.