31st Young Investigators' Seminar on Analytical Chemistry
June 29 – July 2, 2026, Pardubice, Czech Republic

YISAC 2026

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Location and Date

The lectures of YISAC 2026 conference will take place in the C1 lecture hall, located in the first floor of building HA in Faculty of Chemical Technology, University of Pardubice, Studentská 573, Pardubice, from June 29 to July 2, 2026.

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YISAC 2026 PROGRAM

MONDAY, JUNE 29

17:00 REGISTRATION – Entrance Hall at Faculty of Chemical Technology, University of Pardubice, Studentská 573, Pardubice (building HA, 1st floor)

18:00 GET-TOGETHER PARTY – Entrance Hall (building HA, 1st floor)

TUESDAY, JUNE 30

8:00 REGISTRATION

9:00 OPENING CEREMONY – Lecture Hall C1 (building HA, 1st floor)

SESSION 1 **Sensors I** Chairs: **T. Mutić, M. Koderman**

9:20 Andrej Kukuruzar
Development of an Electrochemical Sensor Based on Holmium Nickelate@MWCNT Composite for Diuron Detection

9:40 Weigeng Liu
Development of an Electrochemical Genosensor for Sensitive and Selective Detection of Citrus Bark Cracking Viroid (CBCVd)

10:00 Tia Kralj
Label-Free $Ti_3C_2T_x$ MXene-Based Impedimetric Immunosensor for Sensitive Interleukin-6 Detection

10:20 Ana Kuprešanin
A Fast, Reliable, and Reproducible Electrochemical Sensor for NPK Nutrient Monitoring

10:40 – 11:00 COFFEE BREAK

SESSION 2 **Electrochemistry I** Chairs: **M. M. Dzemidovich, J. Vobořil**

11:00 Ivan Konjević
Electrochemical Impedance Spectroscopy for Investigating Surface Tension Changes and Surfactant Charge Differentiation at a Mercury Electrode

11:20 Dominik Novák
Electrochemical Detection of Ergosterol as a Biomarker of Fungal Contamination in Food Using Screen-Printed Electrodes

11:40 Jelena Tomić
Voltammetric Determination of Lead Using Graphene / Ionic Liquid / Nafion / Bismuth-Modified Carbon Electrodes: Method Development and Analytical Characterization

12:00 – 14:00 LUNCH

SESSION 3 **Other Methods I** Chairs: **K. Lang, D. Šlemar**

14:00 Tina Carola Spirk
Cell History Effects on Fluoride Release and Electrolyte Degradation during Low-Temperature LIB Recycling

14:20 Neža Kralj
Multi-Method Investigation of Dark Brown Carbon in Urban Aerosols

14:40 Julia Truschner
Distinct Arsenic Speciation Patterns in Mushrooms: Analytical Strategies for Complex Matrices

15:00 Ondřej Morávek
Stability of Monoclonal Antibody-Based Therapeutics in Hospital Pneumatic Tube Transport System

15:20 – 15:40 COFFEE BREAK

SESSION 4 **Mass Spectrometry** Chairs: **N. Kralj, D. Novák**

15:40 Martina Piroutková
Chemometric Optimization of Q-ICP-MS for Lead Isotope Analysis in Biological Samples

16:00 Franziska Peer
Development of an ICP-MS/MS Approach for Fluorine Analysis: Comparative Evaluation of the $[BaF]^+$ and $[SrF]^+$ Methods

19:00 SUPERVISORS DINNER - GARDEN
Restaurant & Pension, U Stadionu 2030

WEDNESDAY, JULY 1

SESSION 5 **Sensors II** Chairs: **A. Leda, A. Mijajlović**

9:00 Mitja Koderman
Advanced Nanobody-Based Electrochemical Biosensor for Sensitive Detection of Prostate Cancer Biomarker

9:20 Slavica Mitrović
Electrochemical Performance of Zirconium-Based UiO-67 Composite toward Heavy Metal Sensing in Water

9:40 Ivan Mitevski
Nanomaterial-based Electrochemical Genosensor with Enzyme-Assisted Recycling Amplification for Pathogen Identification

10:00 Tijana Mutić
Electrochemistry at the Fingertips: Wearable Glove-Based Pr_2O_3/MWCNT Nanocomposite Electrode for Carbendazim Detection

10:20 – 10:40 COFFEE BREAK

SESSION 6 **Other Methods II** Chairs: **T. Kralj, O. Morávek**

10:40 Kristýna Dvořáková
Preliminary Study of Enzymatic Epoxidation of Selected Unsaturated Compounds using Microbial Lipases

11:00 Daniel Šlemar
Degradation of Lignosulfonate-Based Superplasticizer Under Simulated Deep Repository Conditions: An Analytical Study

11:20 Karolína Lang
Functionalized Crosslinked Hyaluronic Acid Nanoparticles for Cellular Imaging

11:40 Jakub Vagunda
Comprehensive Characterization of LiAl Mixed Oxides and Analysis of Acetaldehyde Self-Condensation Products

12:00 – 14:00 LUNCH

SESSION 7 **Electrochemistry II** Chairs: **A. Kuprešanin, I. Konjević**

14:00 Jakub Vobořil
Voltammetric Determination of Two Structurally Related Fungicides Folpet and Captan on Carbon-Based Electrodes

14:20 Maryia-Mazhena Dzemidovich
Thin Organic Film Electrodes for Vincristine Analysis: From Interfacial Kinetics to Indirect Quantification

14:40 Volha Filimonava
Electrochemical Determination of Antidepressant Citalopram Using Boron-Doped Diamond Electrodes

15:00 Sandra Chmiel
Comparative Voltammetric Analysis of Forchlorfenuron using Edge Plane Pyrolytic Graphite and Boron-Doped Diamond Electrodes

15:20 – 15:40 COFFEE BREAK

SESSION 8 **Electrochemistry III** Chairs: **W. Liu, A. Kukuruzar**

15:40 Oleksandra Labzova
Novel Analytical Approach Integrating Hollow Fiber Liquid-Phase Microextraction with Square Wave Voltammetry for the Sensitive and Selective Determination of Formaldehyde in Wood

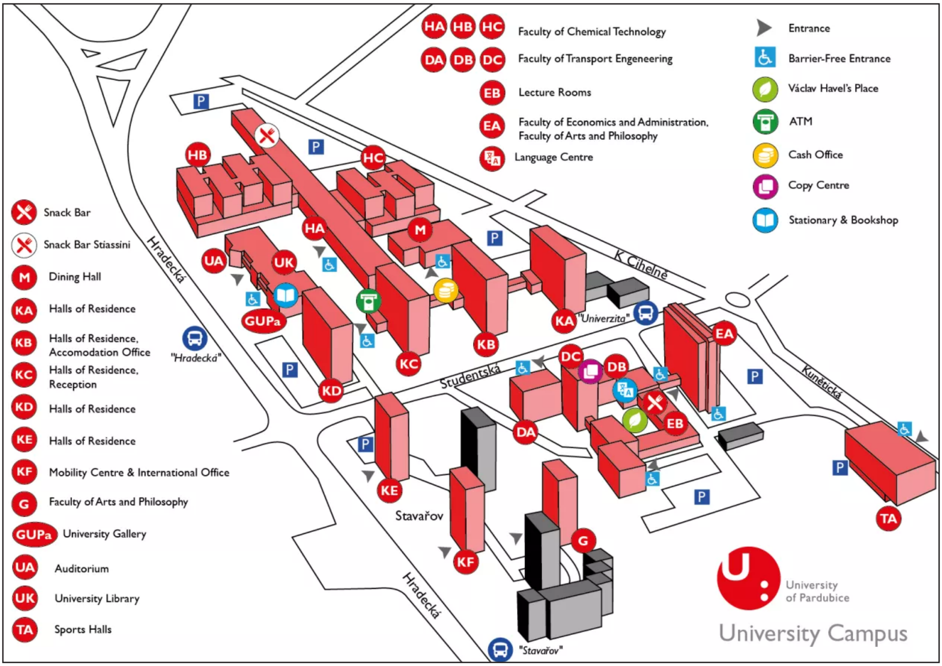
16:00 Aleksandar Mijajlović
Development of an Impedimetric Aptasensor Based on MXene/MWCNT-COOH Functionalized SPCE for Bacillus cereus Spore Detection

16:20 Amanda Leda
Nanostructured Materials Based on Multi-Walled Carbon Nanotubes and Pyrene Derivatives for Electroanalytical and Biosensing Applications

19:00 CONFERENCE DINNER - Na Staré Rybárně, Bulharská 1784.

THURSDAY, JULY 2

10:00 OPTIONAL EXCURSION - Sightseeing tour to old city of Pardubice and chateau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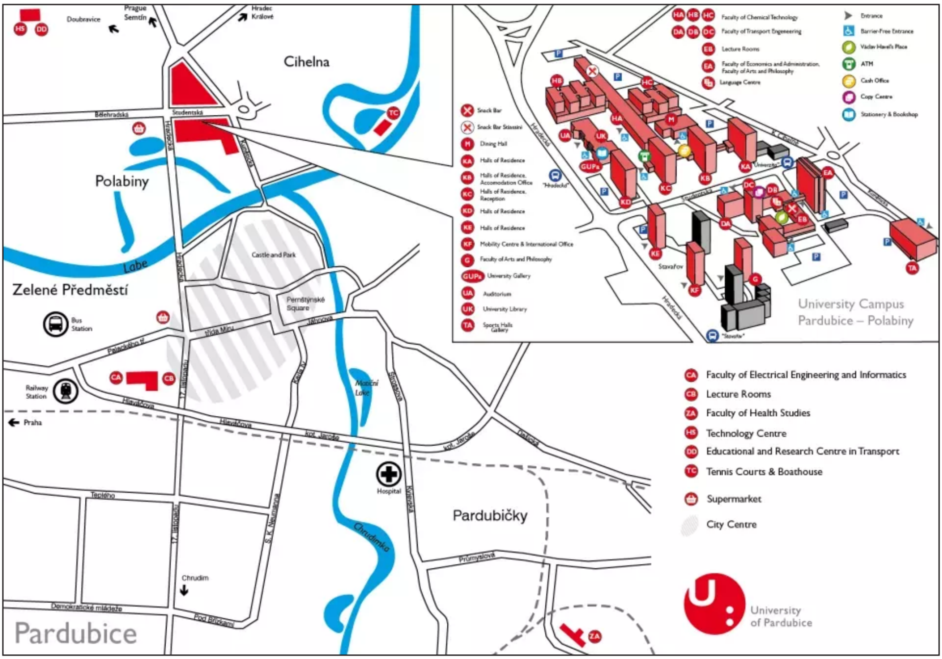
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University Campus Pardubice – Polabiny
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CB Lecture Rooms
ZA Faculty of Health Studies
HS Technology Centre
DD Educational and Research Centre in Transport
TC Tennis Courts & Boathouse
Supermarket
City Centre
University of Pardubice

TUESDAY, JUNE 30

SESSION 1
Sensors I

Development of an Electrochemical Sensor Based on Holmium Nickelate@MWCNT Composite for Diuron Detection

Andrej Kukuruzar[1]*, Tijana Mutić[1], Vesna Stanković[1], Miloš Ognjanović[2], Dalibor Stanković[3]

Diuron is a widely used photosynthesis-inhibiting herbicide with a structure derived from urea. It is a common water pollutant especially harmful to aquatic organisms and has detrimetal effects on human health. For this reason, it is important to investigate sensitive and robust systems for monitoring diuron concentration in environmental samples (1).

In this work, a $HoNiO_3$ perovskite semiconductor was synthesized using a coprecipitation technique and combined with multi-walled carbon nanotubes (MWCNT) in order to create a composite sensing material for diuron. The morphology of the prepared material was determined using SEM, XRD, and FTIR. The composite was applied onto GCE using the drop-casting method and such a modified electrode exhibited superior performance. The electrochemical characterization of the modified electrode was performed in the $[Fe(CN)_6]^{4-}/[Fe(CN)_6]^{3-}$ system using CV and EIS. Optimization of a quantification method for diuron was carried out to determine the best electrochemical technique and its parameters, solution pH, and electrocatalyst composition and loading. Preliminary results using DPV show that diuron detection has a linear response concentration range of 6–130 μM (Fig. 1). Future work will include investigating the effects of interfering substances and applying the developed method to real samples.

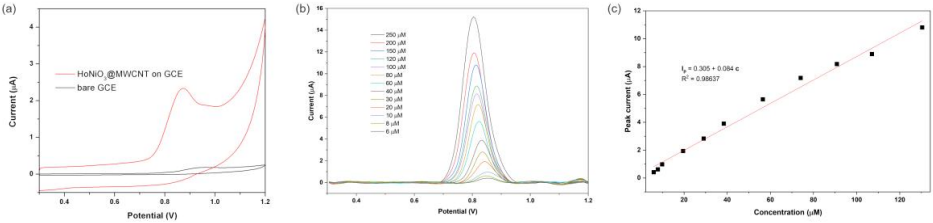

Figure 1. (a) Improved electrocatalytic performance of the GCE modified by the HoNiO3@MWCNT composite in a 100 μM diuron solution at pH 6 using CV; (b) DPV voltammograms for different diuron concentrations at pH 6, with the baseline subtracted; (c) DPV calibration for diuron using the standard addition method.

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Development of an Electrochemical Genosensor for Sensitive and Selective Detection of Citrus Bark Cracking Viroid (CBCVd)

Weigeng Liu[1,2]*, Samo B. Hočevar[1], Nikola Tasić[1]

The hop (Humulus lupulus L.) is an economically important crop with widespread use in beer production, the pharmaceutical industry, the antibiotics industry, etc. Viroids are circular, single-stranded, non-coding RNA molecules of 246–401 nucleotides. Among them, Citrus Bark Cracking Viroid (CBCVd) is one of the most aggressive viroids that can infect hops and cause severe symptoms such as plant stunting, root dry rot, and even plant dieback (1). Since the initial stage of the infection is practically symptomless, its early and reliable detection is crucial for effective preventive measures and disease management. In this context, electrochemical genosensing provides advanced detection strategies to meet the demands for robust and rapid field diagnostics and early monitoring. Combining high sensitivity with cost-effective, operational simplicity and minimal instrumental burden, the electrochemical sensors are widely expected to dominate future decentralized diagnostic markets.

This work presents the development and limitations of a disposable electrochemical genosensor(s) for on-site detection of CBCVd, based on a supporting screen-printed carbon electrode (SPCE). The SPCE is initially modified with different layers, such as gelatin or polyaniline, with or without electrocatalysts, enabling further modification with biorecognition elements and other biosensor building blocks. For the gelatin layer, EDC/NHS chemistry is used to efficiently immobilize aminated capture probes, i.e., target-specific oligonucleotides, followed by deposition of a blocking and anti-fouling layer to minimize nonspecific adsorption and improve genosensor stability. Another strategy involves polyaniline, electrochemically deposited on the SPCE, for glutaraldehyde-assisted linking to the aminated capture probes (2). Preliminary results demonstrated successful, reproducible assembly of the genosensing interface after examining key experimental parameters, including capture probe concentration, incubation time, and temperature. Initial square-wave voltammetric measurements of total RNA samples extracted from hop plants confirmed the feasibility of the proposed genosensing strategy. Further optimization is required to improve the genosensor's electroanalytical performance, particularly linearity and selectivity. The integration of an electrocatalytic interface will be further explored to enhance the genosensor's sensitivity. Given its portable architecture and streamlined operation, the developed genosensing platform will represent a compelling asset for routine on-site viroid monitoring and sustainable agricultural management.

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Label-Free $Ti_3C_2T_x$ MXene-Based Impedimetric Immunosensor for Sensitive Interleukin-6 Detection

Tia Kralj[1,2], Mitja Koderman[1], Milica Počuča-Nešić[3], Katarina Vojisavljević[3], Gregor Marolt[2], Nikola Tasić[1]*, Samo B. Hočevar[1]*

Interleukin-6 (IL-6) is a clinically significant inflammatory cytokine strongly associated with cancer progression, tumor burden, and therapeutic resistance, particularly in prostate cancer. Since conventional biomarkers such as prostate-specific antigen (PSA) often lack sufficient specificity, IL-6 has emerged as a promising complementary biomarker for improved disease diagnosis and monitoring [1]. However, current analytical techniques for IL-6 quantification, including ELISA, CLIA, and flow cytometry, are frequently limited by operational complexity, high cost, prolonged analysis time, and dependence on centralized laboratory infrastructure [2,3]. Consequently, the development of rapid, highly sensitive, and reliable point-of-care detection platforms remains an important analytical challenge. In this work, a label-free electrochemical impedimetric immunosensor for sensitive IL-6 detection was developed using delaminated $Ti_3C_2T_x$ MXene functionalized with (3-aminopropyl)triethoxysilane (APTES) as a conductive nanostructured interface. A controlled biofunctionalization strategy employing glutaraldehyde enabled immobilization of protein A onto the APTES-modified $Ti_3C_2T_x$ MXene surface, allowing oriented attachment of anti-IL-6 antibodies while preserving their antigen-binding activity. Subsequently, bovine serum albumin (BSA) was used as a blocking agent to reduce nonspecific adsorption. After optimization of key analytical parameters, the developed immunosensor enabled IL-6 detection over a diagnostically relevant concentration range with an ultra-low detection limit of 6.7 fM. The rapid label-free assay (30 min) demonstrated excellent selectivity and reliable performance in spiked human serum samples. These results highlight the potential of the $Ti_3C_2T_x$ MXene-based platform for sensitive cytokine monitoring and future point-of-care diagnostics.

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A Fast, Reliable, and Reproducible Electrochemical Sensor for NPK Nutrient Monitoring

Ana Kuprešanin[1]*, Slavica Mitrović[1], Jasmina Anojčić[2], Zoran Pavlović[1]

Assessment of the availability of NPK nutrients (nitrogen, phosphorus, and potassium) provides valuable information for soil fertility evaluation, efficient nutrient management, and sustainable agricultural development. Since nutrient imbalance can affect crop productivity and ecosystems, rapid and reliable analysis is essential. Despite their high accuracy, conventional methods often rely on complex instrumentation, skilled operators, and time-consuming protocols. In this context, potentiometric sensors offer an attractive alternative for rapid, portable, and cost-effective detection under field conditions.

Conducting polymers and nanomaterials are increasingly used as electrode modifiers to improve the performance of electrochemical sensors for NPK-related ions. Conducting polymers such as poly(3-octylthiophene) (POT), polyaniline (PANI), and polypyrrole (PPy) are suitable functional layers due to their conductivity, electrochemical activity, and film-forming ability. When combined with nanomaterials such as MoS_2, graphene, and carbon nanotubes, they can improve charge transfer, increase the active surface area, and enhance the overall response of the sensor platform [1].

Selectivity towards target nutrient ions was achieved by applying an ionophore-based membrane over the conductive nanocomposite layer. The membrane acts as a selective recognition phase for the ions of interest, while the hybrid layer functions as an efficient potentiometric transducer, improving membrane adhesion and charge transfer at the electrode interface. The developed potentiometric sensors showed a stable, reproducible, and very fast response of only 5 s, enabling the analysis of many samples in a short time. The obtained results were in good agreement with spectrophotometric measurements, supporting the reliability of the proposed approach for nutrient detection in complex agricultural matrices [2]. Overall, conducting polymers, nanomaterials, and ionophore-containing membranes represent a promising strategy for advanced potentiometric sensors for NPK monitoring, contributing to faster nutrient assessment, fertiliser optimisation, and sustainable agricultural practices.

The financial support by the Ministry of Education, Science and Technological Development, Republic of Serbia (Project no: 451-03-33/2026-03/200358, 451-03-34/2026-03/200134 and 451-03-33/2026-03/200134) is greatly acknowledged.

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TUESDAY, JUNE 30

SESSION 2
Electrochemistry I

Electrochemical Impedance Spectroscopy for Investigating Surface Tension Changes and Surfactant Charge Differentiation at a Mercury Electrode

Ivan Konjević[1,2]*, Kristijan Vidović[1], Nikola Tasić[1], Samo B. Hočevar[1]

Atmospheric aerosol particles are suspended particles that play a significant role in atmospheric chemistry and climate regulation. A substantial proportion of these particles contains surface-active substances (SAS), which are amphiphilic molecules with both hydrophilic and hydrophobic moieties that accumulate at gas–liquid interfaces and lower surface tension. Such changes in surface tension can affect aerosol nucleation, particle growth, optical properties, size distribution, and cloud condensation nuclei activation.[1]

In earlier work, we developed an electrochemical approach based on alternating current voltammetry to detect SAS-induced changes in interfacial surface tension at concentrations below the detection limits of conventional tensiometric methods used in atmospheric research.[2]

This study builds on this methodology by employing electrochemical impedance spectroscopy to quantify surface tension variations at a mercury electrode. The method involves monitoring changes in double-layer capacitance at the electrode–electrolyte interface due to SAS adsorption. Surface charge values obtained from capacitance measurements are then related to surface tension using the electrocapillary equation. The optimised EIS-based approach enables differentiation and speciation of neutral, cationic, and anionic surfactants in complex mixtures, representing an important step towards more realistic characterisation of surface-active components in atmospheric aerosols.

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Electrochemical Detection of Ergosterol as a Biomarker of Fungal Contamination in Food Using Screen-Printed Electrodes

Dominik Novák[1]*, Iveta Brožková[1], Milan Sýs[2], Marian Vojs[3], Tomáš Mikysek[2], Danjela Kuščer[4], Lucie Korecká[1]

Ergosterol (provitamin D_2, ergosta-5,7,22-trien-3β-ol) is the main sterol of fungal cell membranes and plays the same role as cholesterol in animal cells [1]. Ergosterol is essential for maintaining membrane fluidity, permeability, and structural integrity [2]. Owing to its crucial role in molds, ergosterol is widespread, and can be used as an indirect biomarker of fungal contamination in food, particularly grains and bread. In contrast to mycotoxins, ergosterol is produced from the beginning of the cell cycle and does not require specific conditions for its production [3].

Conventional fungal detection relies on microbiological methods, which are time-consuming [4]. An alternative approach is detection of the toxins, however, they are produced only under specific conditions. Contrary, ergosterol determination is easier and faster [5]. It is detected commonly using HPLC or GC, both frequently coupled with mass-spectroscopy [4]. Other analytical strategies include electronic-nose systems and electrochemical techniques. Electrochemical determination is most commonly performed using voltammetric techniques, especially square-wave voltammetry, with either a glassy carbon electrode (GCE) or a boron-doped diamond electrode (BDDE) [6].

Presented work was focused on the electrochemical detection of ergosterol as a potential biomarker of fungal contamination in food. For electrochemical detection, square-wave voltammetry with screen-printed three-electrode sensors with BDD and GCE were used.

Acknowledgment: This research has been supported by the project of the Faculty of Chemical Technology, University of Pardubice SGS_2026_004.

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Voltammetric Determination of Lead Using Graphene/Ionic Liquid/Nafion/Bismuth-Modified Carbon Electrodes: Method Development and Analytical Characterization

Jelena Tomić[1]*, Slavica Mitrović[1], Ana Kuprešanin[1], Jasmina Anojčić[2], Sanja Mutić[2], Zoran Pavlović[1]

Heavy metal contamination in environmental matrices poses a serious threat to ecosystems and human health. Among these, lead (Pb^{2+}) is of particular concern due to its neurotoxicity and bioaccumulative nature even at trace levels, driving the need for sensitive, selective, and cost-effective detection methods [1, 2].

In this work, glassy carbon (GCE) and carbon fiber electrodes (CFE) were modified with a composite layer of graphene, ionic liquid [BMIM][DCA], Nafion, and an in-situ deposited bismuth film for voltammetric determination of lead. Key parameters including voltammetric technique, pH, deposition potential and time were systematically optimized. Best performance was achieved using DPV with the modified GCE at pH 5.0, deposition potential of −1 V, and deposition time of 240 s, yielding an LOQ of 5 ng/mL, linearity over 5–50 ng/mL Pb^{2+}, and RSD of 7.02%. Simultaneous detection of Pb^{2+}, Cd^{2+}, and Zn^{2+} was also demonstrated, confirming the sensor's potential for multi-analyte environmental monitoring.

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TUESDAY, JUNE 30

SESSION 3
Other Methods I

Cell History Effects on Fluoride Release and Electrolyte Degradation during Low-Temperature LIB Recycling

Tina Carola Spirk[1,2]*, Walter Goessler[1]

The thermo-mechanical approach for lithium-ion battery (LIB) recycling integrates a low-temperature thermal treatment step to remove volatile and potentially flammable electrolyte components before mechanical separation of black mass, separator, housing and current collectors. Although mild conditions (below 100 °C, moderate vacuum) are applied, LiPF6 and organic carbonates are partly degraded, generating hydrogen fluoride (HF), fluorophosphates, and organic acids including formic and acetic acid [1,2]. While it is known that cycling temperature alters electrolyte decomposition and cell stability [3], the effect of cell history on fluoride release during low-temperature recycling has not yet been systematically quantified.

In this study, commercial cylindrical 21700 LIB cells were aged under immersion-cooled conditions in mini-modules. The aged cells were compared to non-cycled reference cells. After recycling the LIB cells, recovered electrolyte and alkaline washing solution – capturing volatiles released during thermal treatment – were analysed using complementary analytical techniques.

Recovered electrolyte consisted mainly of dimethyl carbonate, methyl acetate, acetic acid, formic acid, and further $LiPF_6$ hydrolysis products. Notably, free fluoride concentrations were approximately twice as high in the electrolyte recovered from the less-cycled, thermally more uniformly aged module. Additionally, reversed-phase chromatography of the recovered electrolyte from both aged modules revealed two signals absent in the uncycled reference cells. These degradation products are currently under further investigation.

Covering the broad range of compounds and degradation products required a complementary set of analytical techniques. Future work will extend this workflow by coupling established separation and detection methods, such as IC-ICPMS/MS, to enable the speciation and quantification of fluorine- and phosphorus-containing degradation products formed during low-temperature LIB recycling.

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Multi-method Investigation of Dark Brown Carbon in Urban Aerosols

Neža Kralj[1]*, Samo Hočevar[1], Kristijan Vidović[1]

We recently recognized a class of carbonaceous material in atmospheric aerosol particles, termed dark brown carbon (d-BrC), that has attracted increasing attention due to its potential influence on radiative balance. d-BrC, found in smoke plumes1 and deposited on snow2, consists of insoluble, thermally stable, and atmospherically persistent organic compounds that absorb light in the visible and near-infrared region of the light spectrum. Its optical properties resemble those of black carbon (BC), amorphous carbon that absorbs uniformly across the light spectrum1. Their overlapping optical behaviour introduces uncertainties in the predictions of radiative forcing. Therefore, improving our understanding of d-BrC sources, occurrence, chemical properties, absorbing characteristics, and behaviour and lifecycle in the atmosphere is essential for reducing uncertainties in climate predictions.

To investigate the occurrence and properties of d-BrC in an urban environment, particulate matter collected on quartz fiber filters in Ljubljana was analyzed using a comprehensive multi-technique approach. Water-soluble ions were determined by ion chromatography (IC), levoglucosan and polycyclic aromatic hydrocarbons (PAHs) by gas chromatography–mass spectrometry (GC–MS), optical properties by UV–Vis spectroscopy, and soluble metals by inductively coupled plasma mass spectrometry (ICP–MS). In parallel, particle number concentration and size distribution were measured using a scanning mobility particle sizer (SMPS).

The UV-Vis spectroscopy results revealed enhanced absorption in the visible and near-infrared spectral regions, indicating the persistent presence of d-BrC even at an urban background site. Furthermore, combining chemical, optical, and particle size data with multivariate statistical analysis will enable the identification of dominant d-BrC sources and provide new insight into this still poorly constrained class of atmospheric organic carbon compounds.

Acknowledgments

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Distinct Arsenic Speciation Patterns in Mushrooms: Analytical Strategies for Complex Matrices

Julia Truschner[1]*, Lorenz Steiner[1], Andrea Raab[1], Jan Borovička[2], Bassam Lajin[1] and Walter Goessler[1]

Fungal fruiting bodies are capable of accumulating arsenic in various chemical forms, typically dominated by a single prevailing arsenic species, most commonly methylarsonic acid (MA), dimethylarsinic acid (DMA), arsenobetaine (AB), or inorganic arsenic species such as As(III) and As(V) [1,2]. In general, it is observed that mushrooms follow qualitatively distinct patterns regarding their arsenic speciation profiles in a striking manner. For example, mushrooms with quaternary arsonium compounds tend to produce an incredibly large variety of compounds containing this functional group with or without domination of arsenobetaine, leading to highly complex arsenic speciation profiles. In contrast, other mushrooms produce predominantly compounds with arsenic present in a high oxidation state in methylated and anionic form, exhibiting considerably less complex arsenic speciation profiles. This intrinsic diversity implicates significant analytical challenges, particularly regarding chromatographic separation and comprehensive detection of all arsenic species within these complex biological matrices.

In this work, the distinct patterns in arsenic speciation profiles in mushrooms are presented and their consistency in a variety of species is examined. Further, we address analytical challenges associated with chromatographic separation and determination of diverse arsenic species across different species. Using optimized analytical methodologies based on molecular- and element-selective detection in combination with systematically varied chromatographic conditions, we evaluate strategies that enable the separation of newly identified arsenic compounds from already known arsenic species, involving the recently identified novel arsenic compound glycerophosphorylarsenocholine (As-GPC) in the edible mushrooms Sparassis crispa [3].

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Stability of Monoclonal Antibody-Based Therapeutics in Hospital Pneumatic Tube Transport System

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Monoclonal antibody-based (mAb) therapeutics are a key component of modern cancer biotherapy but are inherently sensitive and susceptible to aggregation induced by handling-associated stress, including agitation, temperature variation, inappropriate dilution, and air–liquid interfacial exposure [1,2]. In clinical settings, these therapeutics are prepared in hospital pharmacies and transported to patients, during which they may be exposed to mechanical stress and variable conditions that can compromise their stability. Aggregate formation may reduce therapeutic efficacy, increase immunogenicity, and trigger infusion-related adverse reactions such as local inflammation and oedema [3]. This work therefore aimed to evaluate aggregation-promoting factors under clinically relevant transport conditions and to assess suitable analytical monitoring approaches.

Aggregation and sample heterogeneity were characterised by protein electrophoresis, size-exclusion chromatography (SEC), and dynamic light scattering (DLS) [4,5]. Amount of protein aggregates retained on in-line filters between the infusion bag and patient was quantified by the bicinchoninic acid (BCA) assay [6]. Transport-associated mechanical stress was monitored using the X-IMU3 inertial sensor during pneumatic tube delivery in a clinical setting. The results demonstrated a pronounced effect of air presence and temperature on aggregate formation highlighting the importance of controlling these factors.

Overall, these findings underline the necessity of systematically defining transport and handling conditions under which the stability of mAb therapeutics is not compromised, ensuring both their safety and therapeutic efficacy during clinical administration.

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TUESDAY, JUNE 30

SESSION 4
Mass Spectrometry

Chemometric Optimization of Q-ICP-MS for Lead Isotope Analysis in Biological Samples

Martina Piroutková[1]*, Lenka Husáková[1], Jan Patočka[1], Jaroslav Semerád[2], Kateřina Poledníková[3], Ivana Kopecká[2], Lukáš Poledník[3], Václav Beran[4], Ivana Vejříková[2], Lukáš Vejřík[2]

Lead isotope ratios represent an important tool for identifying sources of environmental contamination; however, high-precision isotopic measurements are typically performed using specialized instrumentation associated with substantial acquisition and operating costs. In this study, a chemometric approach based on design of experiments (DOE) was employed for the optimization of instrumental conditions for Pb isotope analysis using inductively coupled plasma mass spectrometry with a quadrupole analyzer (Q-ICP-MS). Simultaneous optimization of ten instrumental parameters was achieved by integrating analytical performance criteria related to measurement accuracy and precision into a single optimization framework. The resulting model was used to identify optimal operating conditions and evaluate the influence of individual parameters on analytical performance. The optimized analytical procedure was applied to tissue samples of Eurasian otters (Lutra lutra) together with potential anthropogenic lead sources, including ammunition and fishing sinkers. Multivariate exploratory analysis of elemental composition was used to investigate relationships among biological samples and potential contamination sources. Based on these results, a composite multielement indicator was developed to support sample classification and guide the selection of specimens for subsequent Pb isotope ratio analysis. Isotopic signatures of selected biological samples were subsequently compared with potential contamination sources to evaluate the applicability of the proposed workflow for source discrimination.

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Development of an ICP-MS/MS Approach for Fluorine Analysis: Comparative Evaluation of the $[BaF]^+$ and $[SrF]^+$ Methods

Franziska Peer[1]*, Andrea Raab[1], Raquel Gonzalez de Vega[1], Jörg Feldmann1

In response to upcoming regulatory limits on PFAS in food packaging within the European Union (effective August 2026), the demand for fast, sensitive, and reliable analytical methods for fluorine determination has increased significantly. Inductively coupled plasma tandem mass spectrometry (ICP-MS/MS) represents a suitable analytical approach for fluorine determination due to its rapid analysis times and multi-element detection capabilities.

Direct determination of fluorine by ICP-MS/MS is not feasible because of its high first ionization energy (17 eV), which exceeds that of argon (15 eV). [1] Consequently, indirect approaches based on the formation of metal–fluoride adduct ions have been developed. Barium forms the $[^{138}Ba^{19}F]^+$ adduct due to its high bond dissociation energy for the $[BaF]^+$of 6.39 eV ($[BaO]^+$: 4.00 eV) and a relatively low second ionization potential (10 eV), making it a preferred approach for fluorine analysis. [2] Strontium is also capable of forming adducts, mainly $[^{88}Sr^{19}F]+$; however, due to its slightly lower bond dissociation energy for $[Sr-F]^+$ (5.43 eV; in comparison $[SrO]^+$: 3.06 eV) and a higher second ionization potential of 11 eV, the resulting signal intensity is typically reduced compared to the $[BaF]^+$ method [2].

Despite this limitation, the $[SrF]^+$ approach presents important advantages. In samples containing gadolinium, spectral interferences can compromise the $[BaF]^+$ method on the m/z 157, necessitating an alternative strategy. Additionally, the $[SrF]^+$ method appears to be less sensitive to matrix effects, offering improved robustness across diverse sample types. Coupled with the inherent benefits of ICP-MS/MS, including rapid analysis and multi-element capability, this makes $[SrF]^+$ a compelling complementary approach.

This study aims to critically evaluate the performance of the $[SrF]^+$ method for fluorine determination and to assess its potential as a reliable alternative in cases where the $[BaF]^+$ approach is limited.

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GC×GC-TOF/MS Analysis of Human Scent: Head and Neck Cancer as a Determinant of Forensic Group Affiliation

Lenka Jánošíková[1]*, Oleksii Kaminskyi[1], Ulrika Malá[1], Veronika Škeříková[1], Štěpán Urban[1], Jiří Kubeš[2] - **Lecture was cancelled**

Human scent collected from biological surfaces may serve as a valuable source of forensic information, as it contains volatile organic compounds (VOCs) reflecting both individual metabolic background and potential pathological alterations [1]. When analysed using comprehensive instrumental approaches such as GC×GC–TOF/MS, these chemical traces can provide highly detailed scent fingerprints suitable for comparative and classification purposes in forensic and biomedical applications [2].

Head and neck cancers represent a heterogeneous group of malignancies associated with systemic metabolic reprogramming, which may manifest in altered VOC profiles detectable in human scent [3,4]. Despite increasing interest in scent-based cancer diagnostics, the extent to which oncological disease influences forensic scent classification has not yet been fully established. In particular, it remains unclear whether head and neck cancer can act as a discriminating factor affecting group affiliation based on scent-derived chemical signatures.

Human scent samples were collected non-invasively from volunteers with and without diagnosed head and neck cancer using adsorption onto glass bead sorbents. The analytical workflow employed thermal desorption and comprehensive two-dimensional gas chromatography coupled with time-of-flight mass spectrometry (GC×GC–TOF/MS) to obtain high-resolution chemical profiles [5].

The resulting chromatographic data were evaluated using multivariate statistical methods and machine learning-based classification approaches to assess differences between oncological and control groups. The study focuses on determining whether disease-related metabolic changes are sufficiently reflected in human scent profiles to enable reliable group discrimination, and whether head and neck cancer can be considered a determinant factor in forensic affiliation based on olfactronic analysis.

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WEDNESDAY, JULY 1

SESSION 5
Sensors II

Advanced Nanobody-Based Electrochemical Biosensor for Sensitive Detection of Prostate Cancer Biomarker

Mitja Koderman[1,2]*, Samo B. Hočevar[1], Mitja Kolar[2], Nikola Tasić[1]

Biosensor technologies have emerged as powerful analytical tools for the rapid and sensitive detection of cancer biomarkers. Early detection is essential for improving diagnostic accuracy and patient outcomes. Integration of advanced functional materials and biorecognition elements enables improved analytical performance. Nanobodies have attracted increasing interest for biosensing applications due to their exceptional stability, ease of functionalization, and high antigen specificity [1]. Their integration into electrochemical sensing platforms enables the development of highly sensitive systems for cancer biomarker detection [2].

Prostate-specific antigen (PSA) is one of the most widely investigated biomarkers for prostate cancer diagnosis and monitoring. In our previous work, we developed an electrochemical impedimetric immunosensor that enabled sensitive PSA detection in spiked human serum samples, with a detection limit below clinically relevant concentrations [3]. Building on this platform, the present study introduces a nanobody-based electrochemical biosensor incorporating an advanced electrocatalyst to enhance analytical performance. Owing to their small size, high stability, and favorable orientation through tag-mediated immobilization, nanobodies provide efficient antigen recognition and increased surface binding density compared to conventional antibodies. Future work will focus on validating the developed platform in real clinical samples and evaluating its potential for practical diagnostic applications.

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Electrochemical Performance of Zirconium-Based UiO-67 Composite toward Heavy Metal Sensing in Water

Slavica Mitrović[1]*, Nikolina Tapavica[2], Branko Kordić[2], Zoran Pavlović[1]

The development of advanced materials for environmental monitoring is important for the rapid and sensitive detection of toxic heavy metal ions in water. Electrochemical sensors based on nanostructured materials offer a promising low-cost alternative to conventional analytical techniques due to their portability, fast response, and high sensitivity.

This study presents the synthesis, characterization, and electrochemical application of a zirconium-based UiO-67 metal–organic framework integrated into a UiO-67/graphene/Nafion composite electrode for heavy metal detection. The synthesized UiO-67 showed high crystallinity confirmed by X-ray diffraction (XRD), while scanning electron microscopy (SEM) revealed well-defined octahedral microcrystals. Fourier-transform infrared spectroscopy (FTIR) confirmed characteristic Zr–O vibrations in the 650–770 cm^{-1} region. The incorporation of graphene and Nafion improved the conductivity and stability of the modified carbon fiber electrode.

Electrochemical characterization using cyclic voltammetry with the $[Fe(CN)_6]^{3-/4-}$ redox probe demonstrated enhanced electron transfer and higher current response compared to the bare electrode. Analytical performance was evaluated using differential pulse anodic stripping voltammetry (DP-ASV) in 0.1 M acetate buffer (pH 5) with in situ bismuth film formation. Simultaneous detection of Zn(II), Cd(II), and Pb(II) produced well-defined stripping peaks at approximately −1.10, −0.90, and −0.70 V, respectively. Limits of detection of around 5 ppb were achieved for Pb(II) and Cd(II), while Zn(II) showed a somewhat higher detection limit. The sensor also demonstrated good repeatability during repeated measurements.

The obtained results show that the UiO-67/graphene/Nafion composite is a promising platform for sensitive and reproducible electrochemical monitoring of heavy metals in environmental water samples, with potential for simultaneous multianalyte sensing.

Acknowledgments

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Nanomaterial-Based Electrochemical Genosensor with Enzyme-Assisted Recycling Amplification for Pathogen Identification

Ivan Mitevski[1]*, Nikola Tasić[1], Uroš Javornik[2], Samo Hočevar[1]

Electrochemical biosensors are increasingly used as effective and portable analytical devices, enabling fast, sensitive, and relatively inexpensive detection of biological molecules with no or minimal sample pretreatment steps. A particularly important subgroup is represented by electrochemical genosensors, which are designed for the recognition of selected DNA or RNA sequences. Their operation is usually based on the formation of a hybrid between the target nucleic acid and a complementary capture probe fixed on the electrode surface. This binding event then produces a change in the electrochemical response, which can be measured as the electroanalytical signal. Since genosensors achieve high sensitivity while requiring simple instrumentation and allowing miniaturization, they are being actively studied for medical diagnostics, environmental analysis, and food safety applications [1,2].

For infectious diseases, the detection of nucleic acids originating from pathogens is highly valuable, especially when early, rapid, and on-field diagnostics is required. Since bacteria, viruses, and other microorganisms contain characteristic genetic regions, these sequences can be used as selective markers for their identification [2]. The performance of genosensors has been further improved by introducing additional signal-enhancement strategies. In particular, enzyme-assisted amplification and the use of functional nanomaterials have contributed to lowering detection limits and improving overall genosensor performances [1].

The present work is therefore based on combining these two approaches in one electrochemical genosensing platform. Enzymes will be used to amplify the signal by selectively acting on nucleic acid structures that are produced after hybridization. As a result, even very small amounts of DNA or RNA targets can generate a measurable electrochemical signal [3]. At the same time, electrocatalytic nanomaterials will be incorporated into the genosensing interface to improve charge transfer, increase the available surface area, and support the immobilization of thiol-modified DNA probes [1]. Together, these architectures provide a solid basis for developing sensitive and reliable electrochemical genosensors intended for on-site pathogen detection.

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Electrochemistry at the Fingertips: Wearable Glove-Based Pr_2O_3/MWCNT Nanocomposite Electrode for Carbendazim Detection

Tijana Mutić[1]*, Vesna Stanković[1], Miloš Ognjanović[2], Lazar Rakočević[2], Filip Vlahović[1], Dalibor Stanković[3]

Carbendazim (CBDZ), chemically named methyl-2-benzimidazole carbamate, is a common fungicide, widely used to prevent damage in fruits, vegetables, and cereal crops (1). The excessive use of CBDZ can cause serious health issues, including cancer, liver disease, and chromosome aberration (2). Therefore, there is an urgent need to monitor CBDZ in environmental and food samples.

Interest in the development of wearable sensors has grown significantly in recent years, following advancements in materials science, flexible electronics, microfabrication, and miniaturization techniques, as well as the non-invasive or minimally invasive monitoring of chemical and biological analytes in the human body or its surroundings, often integrated with mobile communication systems (3).

In this work, we present a glove-based electrochemical platform fabricated by direct screen printing of flexible nanocomposite electrodes onto disposable gloves, enabling electrochemical sensing at the fingertips. The working, counter, and pseudo-reference electrodes were sequentially printed using carbon- and silver-based functional inks, followed by surface modification of the working electrode with a nanocomposite layer. A nanocomposite material was synthesized using a simple, hydrothermal approach. The resulting sensor exhibited a broad linear detection range, low detection and quantification limits, and high sensitivity. Its practical applicability was successfully demonstrated in real sample analysis, including fruits and vegetables, and environmental samples. Overall, this work demonstrates a scalable, low-waste, and cost-effective strategy for surface modification through printing, offering a versatile platform for green electrochemical technologies and wearable sensing applications at the human-environment interface.

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WEDNESDAY, JULY 1

SESSION 6
Other Methods II

Preliminary Study of Enzymatic Epoxidation of Selected Unsaturated Compounds using Microbial Lipases

Kristýna Dvořáková[1]*, Lucie Korecká[1]

Epoxides are valuable intermediates for the synthesis of polymers, coatings, lubricants and fine chemicals. Conventional epoxidation process is commonly based on peracids or hydrogen peroxide-based oxidation systems [1, 2]; however, these methods require acidic conditions and often lead to side reactions, particularly in the case of structurally sensitive substrates [3]. Lipase-mediated chemoenzymatic epoxidation represents a milder alternative, based on the in situ formation of a peracid from a carboxylic acid and hydrogen peroxide, followed by oxygen transfer to a carbon–carbon double bond [4].

This work focuses on the enzyme-directed epoxidation of rapeseed-oil fatty acid methyl esters and selected low-molecular-weight unsaturated compounds, namely limonene, pinene, cyclohexene and octene. These substrates were chosen to compare the behaviour of bio-based fatty substrates with terpene-based, cyclic and linear alkenes. The reactions were carried out in toluene at 30 °C for 24 h using Candida rugosa lipase or Rhizopus niveus lipase as biocatalysts, hydrogen peroxide as oxidant, and caprylic or lauric acid as peracid precursors. The reaction products were analysed by infrared spectroscopy (FTIR) to assess spectral changes associated with the conversion of unsaturated bonds and the possible formation of oxirane functionalities. The comparison of fatty acid methyl esters with simpler model alkenes provides a broader view of the applicability of microbial lipases in chemoenzymatic epoxidation systems.

Acknowledgements

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Degradation of Lignosulfonate-Based Superplasticizer Under Simulated Deep Repository Conditions: An Analytical Study

Daniel Šlemar[1]*, Pavel Řezanka[1]

The long-term isolation of radioactive waste in deep geological repositories requires robust engineered barrier systems in which concrete plays a central role. Cement-based materials serve as part of the multi-barrier system, immobilizing waste, limiting radionuclide release and maintaining alkaline near-field conditions over geological timescales. High-performance concrete formulations routinely contain lignosulfonate-based superplasticizers, whose chemical stability under deep geological repository-relevant conditions – elevated temperatures, strongly alkaline environments and ionising radiation – is critical for reliable long-term safety assessment. This study investigates the degradation behaviour of a lignosulfonate-based superplasticizer following exposure to three simulated stressors representative of conditions in the planned Czech deep geological repository: elevated temperature, strongly alkaline solution, and gamma irradiation from a 60Co source [1].

A multi-technique analytical approach was employed to characterise structural changes in the lignosulfonate polymer. FTIR spectroscopy monitored changes in functional groups including sulfonic, hydroxyl and aromatic moieties; thermogravimetric analysis coupled with mass spectrometry (TGA-MS) was used to evaluate the thermal degradation profile of the lignosulfonate; GC-MS enabled identification of low-molecular-weight degradation products; and MALDI-TOF mass spectrometry was employed to determine changes in the molecular mass distribution. Gamma irradiation of organic polymers is known to induce chain scission and alter the concentration of reactive functional groups, with the nature and extent of degradation depending strongly on the applied dose and ambient conditions. The results confirm that both thermal and alkaline stressors significantly alter the lignosulfonate macromolecular structure. The role of gamma irradiation appears more complex: while certain spectral and thermal signatures suggest radiation-induced modification, the precise contribution and mechanism of radiolytic degradation relative to the thermochemical pathways requires further investigation. These findings advance the analytical understanding of concrete admixture stability under deep geological repository conditions [2,3].

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Functionalized Crosslinked Hyaluronic Acid Nanoparticles for Cellular Imaging

Karolína Lang[1]*, Tereza Jirků[1], Jana Báčová[1], Antonín Vlček[1], Jiří Tydlitát[2], Tomáš Roušar[1], Lucie Korecká[1]

Hyaluronic acid (HA) is a naturally occurring polysaccharide and an important component of the extracellular matrix. Owing to its high biocompatibility, HA has attracted considerable interest for biomedical applications. However, its use in soluble form is limited by rapid enzymatic degradation and oxidative fragmentation. To overcome these limitations, crosslinked hyaluronic acid nanoparticles (HANPs) with improved stability and resistance to degradation were developed [1–2].

In this work, HANPs prepared by molecular crosslinking were fluorescently labeled with a newly developed fluorophore derived from formyltriphenylaminopyridinium hexafluorophosphate containing reactive aldehyde functional group. The conjugation strategy relied on the spontaneous reaction between aldehyde groups of the fluorescent probe and amino groups introduced onto the nanoparticle surface. Carboxyl groups present on the HANPs were first activated using carbodiimide based (EDC) chemistry, followed by coupling with adipic acid dihydrazide (AAD), leading to terminal amino groups for subsequent attachment of the fluorophore. Different amounts of EDC and AAD were tested in order to optimize the labeling efficiency and reproducibility of the functionalization process. In addition, the effect of reductive stabilization using sodium triacetoxyborohydride was investigated and compared with non-reduced conjugates.

The prepared fluorescent nanoparticles were characterized by determination of nanoparticles size by dynamic light scattering (DLS), fluorescence measurements, and infrared spectroscopy (FT-IR). Fluorescently labeled HANPs were further evaluated for receptor-mediated reactivity by in vitro experiments with A549 cell line, which overexpress the CD44 receptor [3]. The labeling enabled visualization of nanoparticle–cell interactions and monitoring of cellular uptake, demonstrating the potential of this approach for tracking nanoparticle localization in biological systems.

Acknowledgement

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Comprehensive Characterization of LiAl Mixed Oxides and Analysis of Acetaldehyde Self-Condensation Products

Jakub Vagunda[1]*, Karel Frolich[1], Martin Hájek[1]

The self-condensation of acetaldehyde is an important reaction leading to the formation of α,β-unsaturated aldehydes. The course of the reaction is significantly influenced by the properties of the heterogeneous catalyst, particularly its structure, texture, and distribution of basic sites. This work focuses on the comprehensive analytical characterization of LiAl mixed oxides prepared by calcination of precursors at various temperatures and on the study of their influence on the course of acetaldehyde self condensation. Thermogravimetry (TGA), X-ray powder diffraction (XRD), and infrared spectroscopy (FTIR-ATR) were used to characterize the solid phase. These techniques provided information on the calcination process, phase composition, and surface functional groups of the catalysts. The reaction products were analyzed using GC-MS and FTIR-ATR spectroscopy. In addition to crotonaldehyde, higher condensation products were also identified, such as 2,4-hexadienal, 2,4,6-octatrienal, and hydroxy derivatives formed by subsequent condensation reactions. The obtained data were statistically analyzed to identify correlations between the properties of the catalysts and the distribution of reaction products. The results show a significant influence of the calcination temperature on the phase composition of LiAl mixed oxides as well as on the selectivity of individual condensation products. The study demonstrates the importance of combining analytical methods to describe the relationship between the structure of the heterogeneous catalyst and the composition of the reaction mixture.

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WEDNESDAY, JULY 1

SESSION 7
Electrochemistry II

Voltammetric Determination of Two Structurally Related Fungicides Folpet and Captan on Carbon-Based Electrodes

Jakub Vobořil[1]*, Lenka Janíková[1], Oleksandr Matvieiev[1], Renáta Šelešovská[1]

One of the major global challenges is the continuous growth of the human population, accompanied by increasing demands for crop production. To improve yields and agricultural productivity, pesticides with various modes of action are extensively applied. Folpet (FLP) and captan (CPT) are two structurally related broad-spectrum contact fungicides commonly applied to grapevine, hops, and fruit crops. An important feature of both compounds is their rapid hydrolysis, which significantly affects both their environmental behaviour and analytical determination [1].

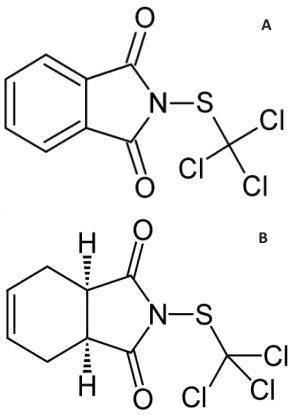

Fig. 1 Structural formulas of FLP (A) and CPT (B).

This study investigated the electrochemical, particularly voltammetric, behaviour of FLP and CPT and subsequently proposed methods for their direct determination. Current analytical approaches are dominated by chromatographic techniques; therefore, the presented voltammetric methods provide a faster and less expensive alternative while also addressing the limited availability of electrochemical methods for these analytes. The study partially builds on historically significant polarographic approaches.

Experiments were performed using glassy carbon electrode (GCE) and boron-doped diamond electrode (BDDE), both characterized by low background current, wide potential window (especially for BDDE), and chemical inertness. Under optimized conditions, FLP provided two voltammetric signals on BDDE and three on GCE at Ep values of approximately −1.0, −1.3, and −1.5 V, whereas CPT exhibited a single peak at approximately −1.6 V. Measurements were carried out in dimethylformamide (DMF) containing 0.1 mol L^{-1} $LiClO_4$. Optimized differential pulse voltammetry and square-wave voltammetry showed wide linear dynamic ranges exceeding three orders of magnitude and low detection limits at the 10^{-7} mol L^{-1} level for both analytes. The proposed methods demonstrated good selectivity confirmed by interference studies, while analyses of model samples and real pesticide formulations provided accurate and precise results. The obtained results were verified using a comparative chromatographic method.

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Thin Organic Film Electrodes for Vincristine Analysis: From Interfacial Kinetics to Indirect Quantification

Maryia-Mazhena Dzemidovich[1,2]*, Andrzej Leniart[1], Sławomira Skrzypek[1], Valentin Mirceski[1,3], Mariola Brycht[1]

Thin organic film electrodes (TOFEs) act as biomimetic platforms for studying charge-transfer processes at soft interfaces. Unlike classical solid electrode / aqueous solution systems, which probe electron transfer, or conventional ITIES arrangements, focused on ion transfer across liquid / liquid boundaries, TOFEs combine both processes within one configuration [1]. A thin water-immiscible organic film immobilized on a conductive electrode forms two active interfaces: (i) electrode / organic phase, where the redox mediator undergoes electron transfer, and (ii) organic phase / aqueous solution, where ion transfer maintains electroneutrality [2].

In this work, a TOFE system was developed for the indirect electrochemical investigation of vincristine (VCR), an anticancer drug from the group of mitotic inhibitors. Since VCR did not show a direct electrochemical response under the applied conditions, its analysis was based on monitoring changes in the signal of a redox mediator. The organic and aqueous phase compositions, as well as the electrode substrate, were optimized to obtain a stable and repeatable TOFE response. The influence of VCR on interfacial processes was examined using cyclic voltammetry and square-wave voltammetry (SWV). The presence of VCR caused a clear decrease in the mediator current response. Analysis of the SWV signal as a function of amplitude and frequency indicated changes in the quasi-reversible behavior of the system, suggesting drug accumulation at the organic phase / aqueous solution interface. This adsorption limits the effectively available interfacial area and slows ion-transfer kinetics. A linear concentration-dependent decrease in current was observed for VCR in the range of 5.0–100.0 μmol L^{-1}, confirming the analytical potential of the optimized TOFE system.

These results demonstrate that TOFEs can serve as sensitive tools for indirect determination of redox-inactive anticancer drugs and for studying their behavior at biomimetic liquid / liquid interfaces.

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Electrochemical Determination of Antidepressant Citalopram Using Boron-Doped Diamond Electrodes

Volha Filimonava[1]*, Kateřina Škurková[1], Oleksandr Matvieiev[1], Renáta Šelešovská[1]

The increasing consumption of antidepressants has created a demand for reliable and sensitive analytical methods for their determination. Citalopram (CTP, Fig. 1), a selective serotonin reuptake inhibitor, is widely used in the treatment of depression and anxiety disorders [1]. Although chromatographic methods remain the standard analytical approach, electrochemical techniques provide faster and less expensive alternative [2,3].

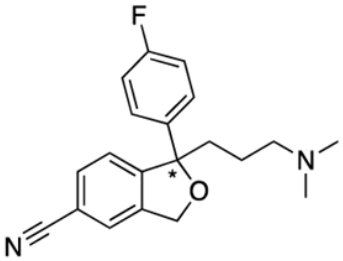

Fig. 1 Structural formula of CTP.

This study focused on the voltammetric and amperometric determination of CTP using boron-doped diamond electrodes (BDDE) and screen-printed boron-doped diamond sensors (SP/BDDE). The electrochemical behaviour of CTP was investigated using cyclic voltammetry (CV), differential pulse voltammetry (DPV), and square-wave voltammetry (SWV). The best analytical response was obtained in 0.01 mol/L NaOH containing 10% acetonitrile, where CTP exhibited three irreversible oxidation peaks. A well-defined signal at +1.1 V was used for electroanalytical purposes. SWV provided higher sensitivity than DPV and was selected for quantitative analysis. The optimized SWV method showed a linear range from 0.5 to 55 µmol/L. The optimized conditions were subsequently transferred to SP/BDDEs, which were subsequently applied both in drop-cast mode and flow injection analysis with electrochemical detection (FIA-ED).

All the developed methods were successfully applied to the analysis of model samples and commercial pharmaceutical formulations on the form of tablets and drops. The obtained results were validated using high-performance liquid chromatography (HPLC), showing excellent agreement between the methods. The study demonstrates that BDDE-based electrochemical techniques provide reliable and cost-effective tools for pharmaceutical quality control of citalopram.

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Comparative Voltammetric Analysis of Forchlorfenuron using Edge Plane Pyrolytic Graphite and Boron-Doped Diamond Electrodes

Sandra Chmiel[1,2]*, Ľubomír Švorc[3], Mariola Brycht[1]

The widespread use of plant growth regulators in modern agriculture, particularly forchlorfenuron (CPPU), a synthetic cytokinin and urea derivative, is essential for enhancing fruit size and yield in crops such as kiwi, grapes, and cucumbers. However, the potential for its accumulation in environmental waters and food products necessitates the development of sensitive and reliable analytical methods for trace determination.

This study presents a comparative voltammetric investigation of CPPU using an edge plane pyrolytic graphite electrode (EPPGE) and a boron-doped diamond electrode (BDDE). Cyclic voltammetry revealed that CPPU is electroactive across the entire tested pH range (2.0–10.0) in Britton–Robinson buffer, with the most well-defined oxidation peak at pH 2.0. The oxidation process on EPPGE was found to be controlled by mixed diffusion–adsorption mechanisms, whereas on BDDE, it was purely diffusion-controlled.

Furthermore, the impact of various BDDE surface pretreatments, i.e., pretreatment by polishing (PPT–BDDE), anodic pretreatment (APT–BDDE), and cathodic pretreatment (CPT–BDDE), was evaluated. Square wave voltammetric (SWV) study indicated that anodic pretreatment significantly enhances the CPPU signal and its repeatability compared to other surfaces.

Using optimized SWV parameters, two linear concentration ranges were established for all electrodes. APT–BDDE demonstrated the superior analytical performance, offering the widest linear ranges of 0.7–10.0 and 10.0–100.0 μmol L^{-1} and the lowest limit of detection of 0.195 μmol L^{-1}. Selectivity studies and the successful analysis of real samples, including river water and fruits (kiwi and watermelon), confirmed the practical utility of the proposed procedure.

In conclusion, the results highlight APT–BDDE as a highly effective sensing platform for CPPU determination, combining high sensitivity and excellent repeatability with minimal susceptibility to surface fouling.

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WEDNESDAY, JULY 1

SESSION 8
Electrochemistry III

Novel Analytical Approach Integrating Hollow Fiber Liquid-phase Microextraction with Square Wave Voltammetry for the Sensitive and Selective Determination of Formaldehyde in Wood

Oleksandra Labzova[1,2]*, Vojtech Hrdlicka[2], Tomas Navratil[2], Rui Miguel Ramos[3], Jose Antonio Rodrigues[3], and Renata Selesovska[1]

A novel analytical approach integrating hollow fiber liquid-phase microextraction (HF-LPME) with square wave voltammetry (SWV) using screen-printed boron-doped diamond electrodes (SP-BDDE) is presented for the sensitive and selective determination of formaldehyde in wood. Formaldehyde is the simplest aliphatic aldehyde, characterized by high polarity (1). It is a common allergen and irritant. Formaldehyde is recognized as a carcinogenic, mutagenic, and teratogenic substance. Inhaled formaldehyde exerts toxic effects on the human body through metabolic binding to proteins and intracellular pools of DNA and RNA (2). Formaldehyde was determined indirectly, using a derivatization method, a chemical reaction occurred between formaldehyde and a derivatizing agent acetylacetone to form a derivative 3,5-diacetyl-1,4-dihydrolutidine (DDL) (3). The extraction and derivatization conditions were systematically optimized with a total analysis time of 15 min. The method exhibited two linear ranges between 0.01-0.1 mmol L^{-1} and 0.1-1.0 mmol L^{-1}, with limit od detection (LOD) of 0.013 mmol L^{-1} and limit of quantification (LOQ) of 0.039 mmol L^{-1}. In this work, we aim to combine gas-phase HF-LPME with in-fiber derivatization, and square wave voltammetry at SP-BDDE for the direct determination of formaldehyde in model solutions and in wood, for the first time. This novel approach can provide higher selectivity, robustness against matrix effects, lower consumption of solvents, and significantly reduced analysis time, opening new possibilities for rapid monitoring of formaldehyde in complex materials.

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Development of an Impedimetric Aptasensor Based on MXene/MWCNT-COOH Functionalized SPCE for Bacillus cereus Spore Detection

Aleksandar Mijajlović[1]*, Jasmina Vidić[2], Slađana Đurđić[1], Miloš Ognjanović[3], Lazar Rakočević[3], Vladimir Rajić[3], Dalibor Stanković[1]

Bacillus cereus, a widespread Gram-positive, spore-forming bacterium, is a frequent cause of food poisoning through the release of emetic and diarrheal toxins [1]. The ability of its highly resilient spores to survive pasteurization and thermal processing makes this pathogen a critical concern for the safety of dairy products and dry foods [2]. In this study, we developed an impedimetric aptasensor designed for the detection of Bacillus cereus spores, leveraging the synergistic effects of MXenes ($Ti_3C_2T_X$) and carboxylated multi-walled carbon nanotubes (MWCNT-COOH). The hybrid nanomaterial was characterized using scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), and Fourier-transform infrared spectroscopy (FTIR). The sensing platform was developed by modifying screen-printed carbon electrodes (SPCE) with the MXene/MWCNT-COOH nanocomposite. To ensure stable bio-reception, an amino-modified aptamer was covalently immobilized onto the carboxyl groups of the nanomaterial surface using EDC/NHS coupling chemistry. Spore detection was subsequently monitored via electrochemical impedance spectroscopy (EIS). Results demonstrate that the developed aptasensor exhibits exceptional selectivity toward Bacillus cereus spores, with no significant interference from other related pathogens. The practical utility of the sensor was successfully validated in real samples of 0% fat milk.

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Nanostructured Materials Based on Multi-Walled Carbon Nanotubes and Pyrene Derivatives for Electroanalytical and Biosensing Applications

Amanda Leda[1,2]*, Barbara Burnat[1], Andrzej Leniart[1], Sławomira Skrzypek[1], Mariola Brycht[1], Tomasz Rębiś[2]

Polycyclic aromatic hydrocarbons (PAHs), including pyrene and its derivatives, remain largely unexplored in analytical electrochemistry, particularly in the development of modified electrodes and amperometric sensors and biosensors. Their incorporation into electrode materials offers a versatile approach for tailoring the physicochemical and electrochemical properties of sensing platforms.

The combination of multi-walled carbon nanotubes (MWCNTs) with pyrene derivatives enables simple, non-covalent assembly via ϖ–ϖ interactions and subsequent electrochemical activation on the electrode surface. This process generates novel redox-active species exhibiting fast electron-transfer kinetics and excellent reversibility in neutral media [1].

In this work, the adsorption of 1-aminopyrene (1-AP) onto MWCNT-modified glassy carbon (GC) electrodes was investigated. Electrochemical activation resulted in the formation of electroactive surface species (GC/MWCNT/1-APox), which enabled the electrocatalytic oxidation of NADH at a low potential (+0.1 V vs. Ag/AgCl) and its determination in both model and real samples.

Moreover, the deposition of catechol and 3-methoxycatechol on GC/MWCNT/1-AP electrodes provided an efficient platform for the immobilization of glucose dehydrogenase from Pseudomonas sp. The resulting biosensing systems allowed glucose determination using two amperometric approaches, demonstrating satisfactory analytical performance.

These findings highlight the potential of MWCNT–pyrene-based nanostructured materials as versatile platforms for electroanalytical and biosensing applications.

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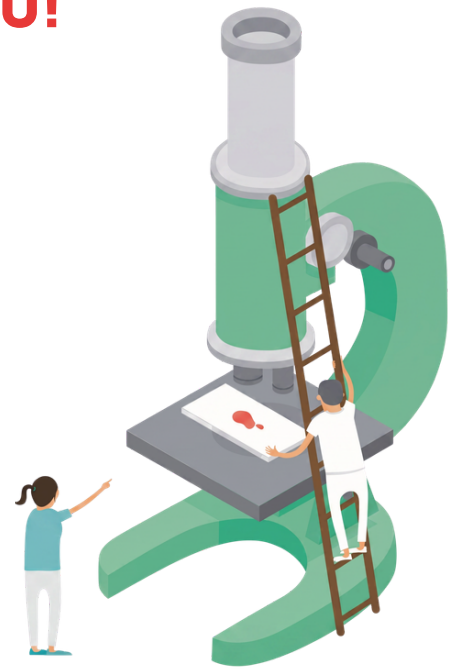

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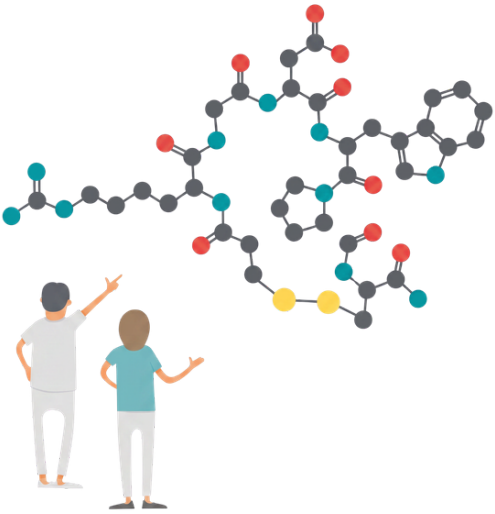

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