MSCA COFUND Doctoral Fellowships “Lignin-Integrated Conductive Polymers for Advanced Applications”

Summary

This PhD topic is part of the INNOCHEMBIO Doctoral Programme, which is funded through the Marie Skłodowska-Curie Actions (MSCA) COFUND action. The main objective of INNOCHEMBIO is to train future experts of sustainable chemistry and biotechnology, helping Europe to take the next steps in the green transition. This project aims to develop eco-friendly organic mixed ionic–electronic conductors (OMIECs) by combining renewable lignin with conductive polymers for advanced biosensor applications. This PhD position will be hosted at TalTech with main supervisor Dr. Yevgen Karpichev and will contain a secondment to co-supervisor Prof. Jean-Manuel Raimundo at Aix-Marseille Université (FR).

Research field:	Chemistry and biotechnology
Supervisor:	Yevgen Karpichev
Availability:	This position is available.
Offered by:	School of Science Department of Chemistry and Biotechnology
Application deadline:	Applications are accepted between July 01, 2025 00:00 and August 31, 2025 23:59 (Europe/Zurich)

Description

1. General description of programme and host

The PhD fellowship is part of the Marie Skłodowska-Curie Actions (MSCA) COFUND doctoral programme INNOCHEMBIO (https://taltech.ee/en/innochembio), which is co-funded by the European Union (Grant agreement 101217295). The main objective of INNOCHEMBIO is to train future experts to help Europe take the next steps in the green transition. The solutions and trained experts can reduce the environmental impact of the chemical and agricultural industries, offer eco-friendly analytical techniques, and assess the safety of new materials. INNOCHEMBIO funding will co-finance **15 PhD positions**, for which the application process in the first call will start on the **1st of July in 2025**.

For 12 PhD positions the hosting institution will be Department of Chemistry and Biotechnology (DCB) at Tallinn University of Technology (TalTech) which combines three divisions – Chemistry, Gene Technology and Biomedicine, and Food and Biotechnology. DCB is developing solutions to the great challenges of the 21st century – climate change, environmental protection, carbon neutrality, renewable energy, and biodiversity conservation. DCB hosts the second biggest PhD programme in TalTech with nearly a hundred enrolled students.

For 3 PhD positions the hosting institution will be the implementing partner – National Institute of Chemical Physics and Biophysics (NICPB). NICPB is a public research institution that conducts both fundamental and applied research, developing novel directions in fields ranging from material sciences to informatics. NICPB houses the Laboratory of Environmental Toxicology and several laboratories focused on fundamental research in NMR technologies with expertise dating back decades. The PhD training activities conducted by NICPB are funded through TalTech.

Importantly, each PhD project has one co-supervisor from another European country, which is detailed under the specific offer (see under supervisors' section). In total, INNOCHEMBIO has **19 associate partners from 11 European countries**.

2. Description of specific PhD project

The rapid expansion of digital health technologies, wearable electronics, and point-of-care diagnostics is driving demand for next-generation biosensors that are not only high-performing but also sustainable and biocompatible. At the heart of many modern biosensors are organic mixed ionic–electronic conductors (OMIECs), which are capable of transporting both ions and electrons. These materials are critical for establishing effective signal transduction between biological systems and electronic devices, enabling real-time detection of physiological and environmental analytes.

OMIECs based on synthetic conjugated polymers—such as polypyrrole (PPy), polythiophene (PT), and their derivatives—have shown strong promise in biosensing due to their tunable conductivity, softness, and compatibility

with aqueous media. However, these materials are typically derived from fossil-based feedstocks, exhibit limited biodegradability, and often require environmentally intensive synthesis routes. To meet growing global expectations around circularity, sustainability, and green chemistry, there is an urgent need to develop OMIECs using renewable and eco-friendly building blocks.

Lignin, an abundant, renewable, and underutilized biopolymer offers a compelling opportunity in this context. As the second most abundant polymer on Earth, lignin features a rich aromatic structure with a variety of reactive functional groups that make it suitable for chemical tailoring and hybridization. Despite its potential, lignin has historically been overlooked in high-value applications such as bioelectronics due to its structural complexity and heterogeneity. However, recent advances in lignin extraction, fractionation, and surface modification have significantly improved its processability and performance in nanocomposites.

This project proposes the development of lignin–conductive polymer bio-nanocomposites as sustainable OMIECs tailored for biosensor applications. These hybrids aim to combine the electrical performance of conjugated polymers with the renewable, biodegradable, and mechanically robust nature of lignin. By leveraging the synergy between these two components, the resulting materials are expected to exhibit improved ionic–electronic transport, mechanical flexibility, and environmental compatibility.

The proposed research includes:

1. Chemical functionalization of lignin to improve solubility, charge transport, and compatibility with conjugated polymers (e.g., sulfonation or oxidative modification).

2. In situ polymerization or grafting of PPy or PT and homemade conductive polymers onto lignin nanoparticles, fibers, or films to create structured OMIECs with controlled morphology and electroactivity.

3. Comprehensive characterization of the physical, electrochemical, and morphological properties of the composites using techniques such as impedance spectroscopy, cyclic voltammetry, SEM, and AFM.

4. Integration into biosensor platforms, particularly for electrochemical detection of biomarkers (e.g., glucose, lactate, heavy metals), where ionic–electronic coupling is essential for sensitivity and stability.

These bio-derived OMIECs are expected to deliver high conductivity, low interfacial impedance, and excellent biocompatibility—key features for wearable and implantable sensors. Furthermore, the use of lignin enables greener synthesis and end-of-life degradation options, aligning with life cycle thinking and circular material principles.

By advancing lignin–based OMIECs, this research supports the development of scalable, cost-effective, and environmentally responsible biosensor technologies. The approach bridges sustainable chemistry and functional materials science, contributing to both fundamental knowledge and practical innovation in bioelectronics and diagnostics.

Link to the project: https://taltech.ee/en/innochembio/karpichev

3. Supervisory team

- Tallinn University of Technology (main supervisor): Dr. Yevgen Karpichev
- Aix-Marseille Université (France): Prof. Jean-Manuel Raimundo (The expected length of long-term mobility is 16 months).

4. Requirements

- Excellent command of written and spoken English.
- Compliance with the rules of INNOCHEMBIO (e.g. eligibility, adhering to MSCA mobility rules, etc.).
- The primary workplace will be in Estonia. Therefore, candidates from outside the EU must be eligible to obtain a visa. The position is expected to start in the first half of 2026.
- The candidate should hold a master's degree (or equivalent) in chemistry, materials science, or a related field.
- A strong foundation in organic synthetic chemistry, polymer science, or electrochemistry is essential.
- Prior experience with biopolymers (e.g., lignin), conjugated polymers, or biosensor development is highly desirable.
- Relevant coursework or research in functional materials will be considered an asset.
- The candidate must demonstrate hands-on skills in chemical synthesis and materials characterization (e.g., spectroscopy, microscopy, electrochemical analysis).
- Strong analytical thinking, teamwork, and communication skills (written and oral) in English are required.
- Motivation to work in an interdisciplinary, innovation-driven research environment is essential.

5. Duties and Responsibilities

- Undertake postgraduate research for specific doctoral research project at TalTech or NICPB, respectively.
- Present and publish research in both academic and non-academic audiences. Attend and participate in academic and non-academic conferences, events and seminars.
- Attend and participate in all training events and supervisory meetings.
- Be seconded to the associated partner as necessary to fulfil the grant obligations.
- Prepare progress reports and similar documents on research for funding bodies, as required.
- Actively contribute to the public engagement and outreach activities of the project.
- The above job descriptions are not exhaustive, the PhD candidate may be required to undertake other tasks, which are broadly in line with the above duties and responsibilities.
- Full-time employment (40 hours per week), temporary contract for 4 years.

6. Eligibility requirements

- The applicant must be a doctoral candidate (i.e. not already in possession of a doctoral degree at the date of the recruitment).
- At the time of recruitment, the researcher must not have resided or carried out their main activity (work, studies, etc.) in Estonia for more than 12 months in the three years immediately prior to the recruitment date. Compulsory national service and/or short stays such as holidays are not taken into account.

7. Benefits

- Competitive funding scheme, with a minimum gross monthly salary of EUR 2500. Topped by additional mobility allowances as well as optional family allowances (if applicable).
- Covered tuition costs, research costs and funding for short term mobility (i.e. conference attendance).
- Interdisciplinary and international research projects.
- Early-stage researcher position, with corresponding social and medical benefits in Estonia.
- Becoming a Marie Skłodowska-Curie PhD fellow.

8. How to Apply

All applications must be sent through TalTech's official application platform Glowbase and only applications submitted here will be considered for the programme. We ask the candidates not to contact the supervisors directly, in case of questions please write at innochembio@taltech.ee. Each application must include the following material: CV, 1-page motivation letter, copies of BSc and MSc study records and diplomas, scanned copy of valid photo ID, 2 reference letters, eligibility statement.

NB! The INNOCHEMBIO programme has additional requirements compared to the standard TalTech application process. Details on the exact nature of these documents and how to insert them in Glowbase can be found at our official INNOCHEMBIO website: https://taltech.ee/en/innochembio/application-process. **If any of the required documents are missing, the candidate will not be eligible to proceed to the selection stage.**

9. Selection Process

The selection and recruitment process will be in accordance with the European Charter and Code of Conduct for the Recruitment of Researchers. The recruitment process will be open, transparent, impartial, equitable, and merit-based. There will be no overt/covert discrimination based on race, gender, sexual orientation, religion or belief, disability or age. To this end, the following selection criteria will be considered.

The application deadline is 31 August 2025. The application process will be carried out in 3 steps. In short, first an eligibility check is performed. All eligible candidates will proceed to stage 1, where they will be evaluated by independent evaluators based on the application documents. Lastly, shortlisted candidates from stage 1 will proceed to stage 2, where they will be interviewed via teleconference, which will be used to determine a candidate to whom an offer will be made. All candidates will be informed about the progress in due course after each step of the process. The selection process is described on the guide for applicants available here: https://taltech.ee/en/innochembio/application-process.

10. Disclaimer

By applying for this position, the applicants

1. give their consent to circulate their application and personal data within the INNOCHEMBIO consortium and with the evaluators;

2. confirm that the data provided is valid and accurate;
3. confirm compliance with the eligibility requirements;
4. commit to undertaking the planned secondment at the co-supervisor’s institution.

To get more information or to apply online, visit https://taltech.glowbase.com/positions/1018 or scan the the code on the left with your smartphone.