

Upcycling of Li-ion battery spent graphite into functional carbonbased materials for energy applications

Summary

This PhD project focuses on the valorization of spent graphite from lithium-ion batteries (LIBs) into functional carbon-based materials for energy applications. While LIB recycling can efficiently recover majority of valuable metals, effective strategies for recovering and reusing spent graphite remain limited. In this project, the spent graphite will be transformed into advanced materials and functionalized through heteroatom and/or transition metal doping to enhance their catalytic performance. The resulting materials will be studied in various electrochemical applications, such as battery electrodes and electrocatalysts.

Research field:	Chemical, materials and energy technology
Supervisor:	Kerli Liivand
Availability:	This position is available.
Offered by:	School of Engineering
	National Institute Of Chemical Physics And Biophysics
Application deadline:	Applications are accepted between June 01, 2025 00:00 and June 30, 2025 23:59 (Europe/Zurich)

Description

The research

Li-ion batteries (LIBs) are one of the most deployed energy storage technologies worldwide, providing power for a wide range of applications—from portable electronic devices to electric vehicles. The growing demand for LIBs, coupled with a shortage of critical battery materials, has prompted the scientific community to seek ways to improve material utilization through the recycling of end-of-life LIBs. While valuable battery metals are already being recycled on an industrial scale, graphite—a material classified as a critical resource—continues to be discarded.

The goal of this PhD project is to explore the upcycling potential of spent graphite from end-of-life lithium-ion batteries (LIBs) as a precursor for advanced carbon-based materials. These materials will be developed and evaluated for use in various electrochemical applications, including battery electrodes and electrocatalysts.

Responsibilities and (foreseen) tasks

- Conduct a comprehensive literature review on LIB recycling, graphite upcycling, and carbon-based materials for electrochemical applications.
- Develop and optimize processes for the purification and structural transformation of spent graphite from end-oflife LIBs.
- Synthesize advanced carbon-based materials through functionalization techniques, including heteroatom and/or transition metal doping.
- Characterize the physicochemical and structural properties of the upcycled materials using a range of analytical techniques (e.g. XRD, Raman, Surface analysis, SEM, TEM, XPS).
- Evaluate the electrochemical performance of the developed materials in applications such as battery electrodes and electrocatalysts.
- Collaborate with other researchers and contribute to interdisciplinary project goals.
- Prepare scientific publications, reports, and presentations to disseminate research findings.

Applicants should fulfil the following requirements:

- A Master's degree in natural sciences or engineering.
- Prior knowledge of lithium-ion battery (LIB) recycling
- Experiences with upcycling spent graphite, rGO synthesis and functionalization of carbon-based materials.
- Ability to work independently as well as collaboratively within an international research team.
- Willingness and ability to contribute to organizational and coordination tasks related to the project.



The following experience is beneficial:

- Background in electrochemistry, including familiarity with rotating disc electrode (RDE) measurements.
- Hands-on experience with material characterization techniques such as XRD and Raman.

Knowledge of sustainable materials development or circular economy principles related to battery technologies.



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