CYCLE OF SEMINARS

"Advanced hybrid materials for innovative energy storage and environmental applications"

Uppsala Universitet – UNISS partnership

C.M. Lerici Foundation Grants

27, 28 and 29 October 2025

15:30

Council Room, Department of Chemical, Physics, Mathematics and Natural Science, Via Vienna, Sassari

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Monday 27 October

- **Electrolytes and binders for lithium- and sodium-ion batteries**

  Dr. Guiomar Hernández – Uppsala Universitet

- **"A solid future for batteries": hydridoborates for next-generation electrochemical energy storage**

  Dr. Fabrizio Murgia – Università di Sassari

Tuesday 28 October

- **Comparing characterization of battery nanomaterials under operando vs ex situ conditions using synchrotron radiation**

  Pr. German Salazar-Alvarez – Uppsala Universitet

- **From waste to valuable chemicals: mechanochemical processes for efficient CO_2 conversion**

  Pr. Gabriele Mulas – Università di Sassari

Wednesday 29 October

- **Engineering bio-based Materials for Fossil-Free Energy Applications**

  Dr. Valentina Guccini – Uppsala Universitet

- **From Structure to Function: Understanding the Formation and Electromechanical Behavior of BCZT Materials**

  Pr. Sebastiano Garroni – Università di Sassari

- **BONUS: Meet the scientist!** Open discussion for MD and PhD Students about career perspective for young researchers among Europe

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UNISS UNIVERSITÀ DEGLI STUDI DI SASSARI

UNISS UNIVERSITÀ DEGLI STUDI DI SASSARI — DIPARTIMENTO DI SCIENZE CHIMICHE FISICHE, MATEMATICHE E NATURALI

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Assistant Professor Guiomar Hernández

Guiomar Hernández is an Assistant Professor at the Ångström Advanced Battery Centre at Uppsala University (Sweden) since 2022. She studied Chemistry and obtained her PhD at the University of the Basque Country (Spain) in 2017 on redox-active polymers for energy storage applications. Currently, she is leading a team working on polymeric materials and electrolytes (solid and liquid) for safe and sustainable next-generation batteries.

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Electrolytes and binders for lithium- and sodium-ion batteries

A battery is composed of two electrodes able to store energy separated by a polymer film that is the separator soaked with a liquid electrolyte able to transport the cations from one electrode to another. Within the electrode, the active material is mixed with a conductive additive to facilitate electron transfer and a binder that glues everything together.

Among all these components, electrolytes and especially binders do not often get as much attention as the active materials. Nevertheless, they are key components that affect the overall cell performance and always remain a secret in battery industry. They are often highly fluorinated, with PF_6^- anions and poly(vinylidene difluoride) (PVdF)-based binders, and considered a requirement for a good battery performance. However, this also brings challenges in terms of sustainability. PVdF falls in the Per- and Polyfluoroalkyl Substances (PFAS) category which are known as "forever chemicals" due to their long persistence and tendency to pollute the environment. PF_6^- anions tend to release hydrogen fluoride (HF) which is toxic and corrosive, thus a safety hazard and problematic during battery recycling. Furthermore, liquid electrolytes are often flammable which compromise the safety of the batteries. Overall, replacing these components with fluorine-free and non-flammable alternatives is a step towards more sustainable and safer batteries.[1]

The presentation will start with fluorine-free electrolytes based on bis(oxalato)borate for lithium- and sodium-ion batteries, focusing on understanding the solid electrolyte interphase formation on graphite, silicon and hard carbon active materials.[2–4] Secondly, solid polymer electrolytes will be introduced to replace the flammable organic solvents, discussing the properties and sustainability requirements.[5,6] Finally, self-healing functionalities aiming to accommodate volume changes during battery cycling will be presented in order to extend the battery lifetime. [7,8]

References

1. Hernández, G., *et al.* Fluorine-Free Electrolytes for Lithium and Sodium Batteries. *Batteries & Supercaps* **5**, e202100373 (2022).
2. Hernández, G. *et al.* Elimination of Fluorination: The Influence of Fluorine-Free Electrolytes on the Performance of LiNi1/3Mn1/3Co1/3O2/Silicon–Graphite Li-Ion Battery Cells. *ACS Sustainable Chem. Eng.* **8**, 10041–10052 (2020).
3. Weng, Y.-C. *et al.* Spatially and Chemically Resolved Degradation of Fluorine-Free Electrolyte on Silicon/Graphite Surfaces. *J. Electrochem. Soc.* **171**, 060527 (2024).
4. Lu, Z. *et al.* Formation and Evolution of the Solid Electrolyte Interphase on Silicon Electrodes from Fluorine-Free Electrolytes. *Small* **21**, 2410654 (2025).
5. Hernández, G. *et al.* Do Non-Coordinating Polymers Function as Host Materials for Solid Polymer Electrolytes? The Case of PVdF-HFP. *J. Mater. Chem. A*, 11, 15329–15335 (2023).
6. Hernández, G. *et al.* Going Beyond Sweep Voltammetry: Alternative Approaches in Search of the Elusive Electrochemical Stability of Polymer Electrolytes. *J. Electrochem. Soc.*, 168, 100523 (2021).
7. Patranika, T. *et al.* Interaction of Boron-Based Cross-Linkers with Polymer Binders for Silicon Anodes in Lithium-Ion Batteries. *ACS Appl. Polym. Mater.* **6**, 12429–12440 (2024).
8. Mai, C.T. *et al.* Inherent limitations of the hydrogen-bonding UPy motif as self-healing functionality for polymer electrolytes. *RSC Appl. Polym.*, **2**, 374–383 (2024).

Professor German Salazar-Alvarez

GSA is an Associate Professor at the Division of Solid State Physics of the Department of Materials Science at Uppsala University since 2019. Previously, he was a group leader in the Department of Materials Chemistry at Stockholm University. His group currently focuses on the correlation of structure-morphology-functional properties of nanomaterials for energy-related applications, including electrocatalysts and Li-ion batteries.

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Comparing characterisation of battery nanomaterials under operando vs ex situ conditions using synchrotron radiation.

Fe_3O_4 is a conversion-type anode material that offers a high storage capacity, approximately three times greater than that of graphite, but suffers from limited cycling performance. Nanosizing Fe_3O_4 is one promising strategy used to enhance its cycling stability and overall electrochemical performance; however, the details of particle size dependent reaction kinetics remain poorly understood. In this work, we investigate the conversion reactions of both bulk- and 50 nm-sized cubic Fe_3O_4 particles as active material using a multi-scale, multi-technique approach, by combining operando XRD, SAXS and magnetometry techniques. The results from the operando X-ray scattering experiments indicate that during initial lithiation reaction, the bulk electrode undergoes phase reduction reactions with a structural breakdown and formation of metallic iron nano grains, whereas the nanoparticle counterpart Fe_3O_4-N retains its ccp oxygen anion framework throughout the lithiation process, hindering structural breakdown and amorphization and delaying the growth of metallic iron nano grains. As a complementary method, operando vibrating sample magnetometry measurements are applied for a cross-check to investigate structural transformation and presence of metallic iron nanodomains owing to its unique sensitivity to local structural details that otherwise might remain hidden in conventional structural characterizations. In addition, the reaction products were found to differ when time-resolved investigations are compared to ex-situ prepared specimens. Thus, these results highlight the critical importance of integrating complementary operando techniques, particularly in contrast to ex situ methods, to capture particle size–dependent lithiation pathways and relaxation mechanisms in conversion-type electrodes.

Assistant Professor Valentina Guccini

Valentina Guccini joined Uppsala University in 2024 as an Assistant Professor at the Division of Macromolecular Chemistry of the Department of Chemistry. She graduated in Chemistry from Sassari University and completed her PhD at Stockholm University in 2019. Her research group investigates the structure-property relationships of bio-based materials, from the molecular to the macroscopic scale, to advance sustainable technologies in biotechnology and fossil-free energy applications. A particular focus is given on nanocellulose, water interaction and colloidal assembly behaviour.

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Engineering bio-based Materials for Fossil-Free Energy Applications

Cellulose nanofibers and nanocrystals (CNFs and CNCs), collectively referred to as nanocelluloses, are bio-based nanomaterials characterised by remarkable chemical and physical versatility. In aqueous suspensions, they self-assemble into liquid crystalline phases and exhibit excellent intrinsic mechanical properties, high water affinity and biocompatibility. Thanks to these characteristics and their versatility, nanocelluloses have been implemented in a wide range of applications, including fossil-free energy technologies. During this presentation, I will describe a strategy to leverage the nanocellulose structure-property relationships from the molecular to macroscopic scales, to reach the specific functionalities of hydrogen fuel cell proton conductive membranes and lithium-ion battery components. I will also offer a perspective on how to conduct interdisciplinary research at the intersection of materials science, microbiology and even art, to inspire innovative and creative approaches to employ in the design of next-generation sustainable materials.

Acknowledgement: *C.M. Lerici Foundation; Co-funded by EU MSCA-IF, HORIZON-MSCA-2021-PF-01 – 101069033 – STREAM Sodium Through Rigid Electrolyte: Advanced Measurements*

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