

MSCA – European Training Network - POLY STORAGE

European Winter School & Workshop
on solid-state energy storage & conversion

March 19-24, 2023 – Sestriere (IT)

TH Resort Olympic Village (<https://www.thsestriere.it/en/>)

The school mainly focuses on solid-state energy storage, related materials, advanced characterisation and production. It is directed towards Early-Stage Researchers from across Europe, a hybrid event with poster presentations by participants.

Info & registration: www.polystorage-etn.eu

Organised by:



Politecnico
di Torino



FRIEDRICH-SCHILLER-
UNIVERSITÄT
JENA



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 860403.

Lecturers

- Dominic BRESSER, Helmholtz Institute Ulm (HIU-KIT) – DE
- Sergio BRUTTI, University of Rome “La Sapienza” – IT
- Alejandro A. FRANCO, Université de Picardie Jules Verne – FR
- Miran GABERŠČEK, National Institute of Chemistry – SL
- Teresa GATTI, Politecnico di Torino – IT
- Patrik JOHANSSON, Chalmers University of Technology – SE
- Rebeca MARCILLA, IMDEA Energy Institute Madrid – SP
- David MECERREYES, POLYMAT Univ. of the Basque Country – SP
- Piercarlo MUSTARELLI, University of Milan “Bicocca” – IT
- Maria I. ONORATO & Sara ROLLINO, Politecnico di Torino – IT
- Nagaraj PATIL, IMDEA Energy Institute Madrid – SP
- Olivier ROUX, Bio-Logic Science Instruments – FR
- Riccardo RUFFO, University of Milan “Bicocca” – IT
- Alexander S. SHAPLOV, LIST – Luxemburg
- Ulderico ULISSI, Sphere Energy SAS – FR
- Leire ZUBIZARRETA, Instituto Tecnológico de la Energía, ITE – SP

Organisers

- G.A. Elia, C. Gerbaldi, G. Meligrana, A. Piovano, Politecnico di Torino – IT
- M. Destro, COMAU – IT
- M. Jäger, S. Münch, U.S. Schubert, University of Jena – DE

Advisory Board

- D. Brandell – SE
- R. Dominko – SI
- K. Edström – SE
- C. Gerbaldi – IT
- J.-F. Gohy – BE
- R. Marcilla – SP
- D. Mecerreyes – SP
- T.M. Bowden – SE
- V. Miroslavov – SP
- S. Passerini – GE
- L. Rubatat – FR
- J. Ruokolainen – FI
- M. Forsyth – AU
- U.S. Schubert – DE

Partnership



L1 - SUNDAY 19/3: The Good, the Bad and the Ugly of the (Battery) publication process

Some short more information about the lecture include: "What does the battery publishing landscape look like and how has it evolved along the years? What are the trends in scientific journals, etc.? This is one axis of the presentation.

The other and the major axis is what to think about when you submit a (battery) manuscript; What are the next processes - from different perspectives: author, editor, and reviewer."

Prof. Patrik Johansson, Chalmers University of Technology – SE



PhD in Inorganic Chemistry from Uppsala University (1998), he is full Professor in Physics and leader of a group of ca. 10 PhD students and postdocs. He is co-director of ALISTORE-ERI, one of EU's largest industry-academia networks in modern batteries, and vice-director of the Graphene Flagship. He continuously aims at combining the understanding of new materials at the molecular scale, often via *ab initio*/DFT computational methods and IR/Raman spectroscopy, with battery concept development and real battery performance – with a special interest in all kinds of electrolytes. He is currently active in several large battery projects, such as BIG-MAP and DESTINY. His team won the Open Innovation Contest on Energy Storage arranged by BASF in 2015 for his new ideas on Al-battery technology.

L2 - MONDAY 20/3: Towards all-solid-state Li-based batteries: research & beyond

The experimental demonstration of solid-state batteries beyond the lab-scale opens extraordinary research challenges but also discloses remarkable opportunities in terms of operation safety and industrial scale-up. Starting from the fundamentals of the solid-state electrochemistry of aprotic Li-batteries (ionic conductivity at the solid state, active materials modification upon charge/discharge, volume variations at cell level, extended defect formation, thermal effects, role of metallic plating/stripping...), here we tackle the analysis of the current critical points and open challenges.

Prof. Sergio Brutti, University of Rome "La Sapienza" – IT



Associate professor in physical chemistry at the University of Rome La Sapienza (Uniroma1). After the Master and PhD in Materials Chemistry, he had various post doc experiences in Italy and abroad (UK) shifting his research interests from thermodynamics to energy materials. In the last decade, he is focusing on advanced energy materials for secondary batteries. At the University of Rome La Sapienza, he is co-leader of the ENAM (Electrochemistry and Nanotechnologies for Advanced Materials) research group together with Prof. Maria Assunta Navarra.

L3 - MONDAY 20/3: Innovative polymer electrolytes for next-generation batteries

The next generation batteries would need the development of innovative polymers that help to improve their performance in terms of power density, cyclability, raw materials availability, low weight, printability, flexibility, sustainability or security. The lecture will be devoted to explain design principles and different methods to synthesize and process polymer electrolytes for solid state batteries. Through the lecture, recent developments in the area of polymer electrolytes, including PDADMA type poly(ionic liquid) electrolytes and new single-ion conductors will be reviewed.

Prof. David Mecerreyes, POLYMAT - University of the Basque Country - SP



PhD in polymer chemistry by the University of Liege, in 2011 he became Ikerbasque Research Professor at POLYMAT, University of the Basque Country. Since then, he coordinates the Innovative Polymers Group and acts as scientific vice-director of POLYMAT. His actual research interests include the synthesis of innovative polymers for energy and bioelectronics. In particular his team is dedicated to polymer chemistry of innovative redox polymers, poly(ionic liquid)s, iongels and conducting polymers. He is co-author of more than 350 scientific articles and co-founder of the start-up company POLYKEY.

L4 - MONDAY 20/3: Charge transport in (hybrid) polymer-based electrolytes

The lecture will cover some fundamentals about the different commonly used electrolytes in rechargeable batteries, including liquid and solid as well as hybrid systems, along with several examples from the recent literature. A particular focus will be on the different charge transport mechanisms and polymer-based electrolytes for lithium batteries.

Dr. Dominic Bresser, Helmholtz Institute Ulm (HIU-KIT) – DE



Currently serving as principal investigator at the Helmholtz Institute Ulm (HIU) and Karlsruhe Institute of Technology (KIT), Germany. His research focuses on the development of advanced lithium and sodium batteries. In addition to his role at KIT-HIU, he is serving as editor for the Journal of Power Sources Advances (Elsevier). Very recently, he has been awarded with the Carus Medal for his scientific achievements by the German National Academy of Sciences Leopoldina, the Carus Award by the city of Schweinfurt, Germany, and an ERC Starting Grant by the European Research Council.

L5 - TUESDAY 21/3: An overview on battery cells manufacturing processes: from conventional to solid state batteries

The lecture will give an overview of the processes and techniques involved during the steps of the manufacturing process of conventional lithium batteries. Steps for electrode production as well as cell assembly and the most important parameters involved in each step will be elucidated. Innovative techniques for the manufacturing of the next generation cell chemistries, such as solid-state technologies, will also be discussed.



Dr. Leire Zubizarreta, Instituto Tecnológico de la Energía, ITE – SP

PhD in Chemistry by the University of Oviedo - INCAR-CSIC research center. In 2009, she joined the Instituto Tecnológico de la Energía (ITE, Valencia), and now has 18 years of research experience in new materials development for energy applications. At ITE, she leads the research line related to new materials and components for electrochemical energy storage (mainly Li-ion batteries) and she coordinates and participates in several regional, national and international project related to this topic. She is teacher at MBATT Master "Continuing Education in battery Technologies".

L6 - TUESDAY 21/3: Battery manufacturing process modeling with numerical simulation and AI

This lecture will discuss a computational modeling methodology to create a digital twin of the manufacturing process of Li-ion batteries. Such a methodology encompasses numerical simulation and machine learning, allowing to predict the influence of manufacturing parameters on the interfaces between active and inactive materials within the electrodes and on cell electrochemical response. The approach is also demonstrated for sodium ion and solid-state batteries. In a comprehensive way, I will explain how this methodology can be used to optimize battery electrodes and cells. At the end of the lecture, a Virtual Reality competition will be also proposed to the audience in order to "learn by doing" about battery manufacturing and its digitalization.



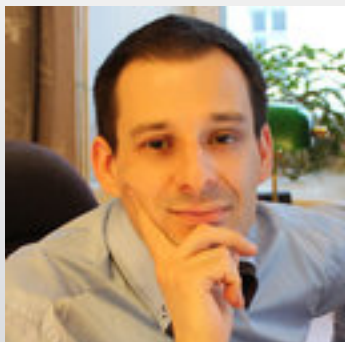
Prof. Alejandro A. Franco, Université de Picardie Jules Verne – FR

Full professor at the Université de Picardie Jules Verne, in Amiens, France. He is Honorary member of the Institut Universitaire de France. He is ERC (Consolidator and Proof of Concept) Grantee. He leads the Theory Open Platform at the ALISTORE European Research Institute and he is the Chairman of the LiPlanet Expert Group "Digitalization, Measurement Methods and Quality". He is also consulting expert of an important battery gigafactory company. His expertise is about batteries and their manufacturing and the application of multiscale modeling and artificial intelligence to optimize them.

L7 - TUESDAY 21/3: How to design conductive poly(ionic liquid) and avoid mistakes with measurements

The lecture will be dedicated to the design of the ionic monomers and the influence of their structure on the ionic conductivity of obtained polyelectrolytes. It will explain the rules how to purify the polymer, why it is important to clean and correctly dry it, connecting these points with conductivity of final materials. Lastly the lecture will provide the insight into the possibility of properties improvement by playing with the macroarchitecture of the polyelectrolytes.

Prof. Alexander S. Shaplov, Luxembourg Institute of Science and Technology (LIST) – LU



Associate professor at Materials Research and Technology Dept. Team oriented, highly accomplished polymer chemist with 19 years of experience in state-of-the-art research and new approaches for monomer and polymer synthesis, creation of polymeric advanced materials, innovative ionic polyelectrolytes with high conductivity, polymeric composite materials, ionic liquids and fabrication of electrochemical devices for energy related applications. Exceptional record of success performing and leading complex, high-level Academic research and industrial research for Merck KGaA, Samsung, LG, Goodyear in Ionic Liquids and Polymer Engineering.

L8 - TUESDAY 21/3: NMR information on structure and ion dynamics: from ex situ, to in situ and operando approaches

The lecture will start by introducing the fundamentals of NMR, chiefly for what the interactions in the solid state are concerned. Then, some examples will be given about ex-situ applications on electrode and electrolyte materials. The focus will be then moved to in-situ and even operando approaches, also by considering the combination of spectroscopy and microimaging.

Prof. Piercarlo Mustarelli, University of Milan “Bicocca” – IT



Full professor at the Department of Materials Science. Starting in the 80s, he developed solid state NMR instrumentation that was lately applied to ionic conductors as glasses, polymers, ionic liquids, etc. During the last 30 years he studied electrolyte and electrode materials for lithium batteries, fuel cell and electrolyzers. In 2020 he founded the National Reference Center for Energy Storage Systems (GISEL), of which he was coordinator for the two-year period 2020-2021. He is responsible for UNIMIB of the Lombardy regional laboratory R2BATT on the recycling and reuse of batteries and part of the Secretariat of Batteries Europe. He published more than 280 papers on international journals.

L9 - WEDNESDAY 22/3: Beyond standard Li-ion: next generation of Li batteries and alternative chemistries

Starting with the state of the art in lithium batteries, the lecture will focus on the electrode materials that will characterize the next generations of rechargeable batteries, from secondary lithium metal batteries with lithiated and/or non-lithiated positive electrodes to the most promising alternative chemistries (Na, K, Al) and the different approaches in their design.



Prof. Riccardo Ruffo, University of Milan "Bicocca" – IT

Full Professor of Physical Chemistry and Electrochemistry at the University of Milano Bicocca. He got the Master Degree in Chemistry (1997), the Master Degree in Materials Science (2001), and the Ph.D. in Material Science (2004). In 2008 and in 2014 he was Visiting Scholar at the Stanford University. His research interests cover materials for energy production and storage, mainly electrodes for alkali-ion batteries and semiconducting polymers for electro-optical applications such as photovoltaics and electrochromism. He is also expert in the electrochemical characterization of organic molecules.

L10+L11 - WEDNESDAY 22/3: Horizon MSCA Postdoctoral Fellowship: an opportunity after the PhD award + European Research Council grants (ERC): why it is important to know that this funding programme exists and how to walk towards it

aka hints on research proposal preparation & submission under EU funding

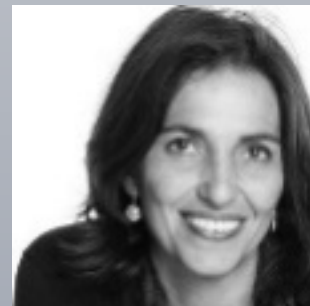


Dr. Sara Rollino, Politecnico di Torino – IT

Research Adviser specialized in individual and career development funding opportunities mainly within Marie-Sklodowska-Curie Actions (MSCA). Her duties include internal training activities on Horizon calls of interest to the University, e.g. MSCA Postdoctoral Fellowships, through the annual organisation of thematic Info days and writing workshops, and support in the proposal preparation phase, providing a dedicated review of the non-scientific parts of proposals. She also plays as department advisor for Open Access, Open Data and more broadly Open Science practices.

Dr. Maria Onorato, Politecnico di Torino – IT

Research Adviser dedicated to the ERC since 2012. She is project manager for ERC@PoliTo, an initiative promoted by Politecnico di Torino to support excellent young researchers with the objective of improving their participation to the ERC and facilitate the management aspects for ERC grant winners. She is head of the Individual funding and basic research grant office both for national and European calls (MUR: Prin/FISR/FIS/Young Researchers – EC: ERC, MSCA, EIC PF).



L12 - THURSDAY 23/3: Redox polymers as organic electrodes for batteries

Redox polymers are proposed as promising organic electrode materials for smart, scalable, safe, and sustainable electrochemical energy storage devices. They bring advantages in terms of cost-benefits, diversity, good processability, unique electrochemical properties, making them as versatile candidates for various energy storage devices. In this lecture, development of diverse redox polymers as electrode active-materials in different organic battery technologies, ranging from monovalent Li-ion-to-trivalent Al-ion, including all-polymer batteries will be covered.



Dr. Nagaraj Patil, IMDEA Energy Institute Madrid – SP

PhD from University of Liege, Belgium in 2017, under the supervision of Prof. Christine Jerome. Then he joined IMDEA Energy Institute in November 2017 as a postdoctoral position in the group of Electrochemical Processes Unit. Since January 2023, he holds a Senior Assistant Researcher position. His research interests focus on organic electrochemical energy storage, with special enforcement to emphasize on an integrated approach of synthetic polymer chemistry (redox-active polymers and conducting polymers) and applied electrochemical technologies (metal-polymer and all-polymer batteries).

L13 - THURSDAY 23/3: Recent advances and future challenges of redox flow batteries

Redox-flow batteries, based on their particular ability to decouple power and energy, stand as prime candidates for cost-effective stationary storage. This lecture aims at reviewing the different redox-flow technologies from mature all-vanadium RFB to more recent alternatives such as organic and polymer RFB ending with disruptive concepts such as membrane-free RFB or mediated-RFB. It summarizes advantages and weaknesses of different technologies and presents the future challenges in terms of both material and component development and the search for innovative designs.



Dr. Rebeca Marcilla, IMDEA Energy Institute Madrid – SP

Senior Researcher of the Unit of Electrochemical Processes of IMDEA Energy. During her fruitful scientific career, she has acquired proven experience in advanced materials for energy storage (e.g., ionic liquids, polymer electrolytes, redox-active polymers) and electrochemical energy storage technologies (e.g., supercaps, Li-ion batteries, organic and redox flow batteries). She co-authored 7 patents and more than 110 articles, achieving an h-index of 44. In 2017, she was awarded with an ERC Consolidator Grant to develop a new concept of membrane-free redox flow battery. Moreover, she has been PI of several European projects including POLYSTORAGE Marie-Curie ETN.

L14 - THURSDAY 23/3: Impedance spectroscopy: basic principles, qualitative analysis of materials/interfaces

In the lecture, general importance of impedance spectroscopy and basic principles will first be presented. After discussing a qualitative analysis of the main features of impedance spectra, a couple of easy-to-perform quantitative calculations will be introduced to determine main materials parameters, such as conductivity, dielectric constant, exchange current density or diffusion coefficient. Finally, complications arising due to poor contacts in solid-solid interfaces or other defect structures will be presented and discussed.



Prof. Miran Gaberšček, National Institute of Chemistry – SL

Professor of Materials Science, he is Head of Department for Materials Chemistry at the National Institute of Chemistry, Ljubljana, Slovenia. He is also affiliated to the University of Ljubljana. His primary research field has been electrochemical systems for energy storage and conversion (batteries, fuel cells). His main focus has been the explanation of complex charge transport and reaction mechanisms using impedance spectroscopy. Prof. Gaberšček has published about 250 papers, some of them in prestigious journals such as Nature Materials, Angewandte Chemie, Advanced Materials and similar.

L15 - THURSDAY 23/3: How to understand easily electrochemical impedance spectroscopy (EIS) with the hands

The target of this lecture is to understand, in an easy way, the principle of the Electrochemical Impedance Spectroscopy (EIS), what is the link between the instrument, the signal, the electrons, the ions and the materials under study. Finally, details will be given on how to perform a good impedance measurement and how to be sure of the results.



Dr. Olivier Roux, Bio-Logic Science Instruments – FR

Electrochemical Engineer, he is the direct Sales Manager Europe of Biologic SAS. He has been working for more than 25 years in the field of laboratory instrumentation and more particularly in potentiostats / galvanostats, battery cyclers and electrochemical impedance spectroscopy analysers.

L16 - FRIDAY 24/3: The state of batteries market, industry and academic tech transfer

This lecture will give an overview of the lithium-based batteries market, with projections up to 2030, and discuss the potential timeline for the commercialization of solid-state batteries. The necessary steps will be discussed for bringing new technologies from the research laboratory scale to the market, including the complexities of automotive validation and creating value chains for mass-market.



Dr. Ulderico Ulissi, Sphere Energy SAS – FR

Advisor at Sphere Energy SAS, working on technical due diligence. Before, he worked as Battery Research Lead at Rho Motion, as Battery Research Engineer at Nissan Motor Co., Ltd. and as Senior Scientist at OXIS Energy Ltd.. He has published 19 peer-reviewed papers and one book and filed 5 patents in collaboration with several industrial partners such as BMW AG, Samsung R&D Japan, EVONIK Ind. AG, OXIS Energy Ltd. He was awarded his doctorate (chemistry) in 2017 from the Karlsruhe Institute of Technology (Germany). Ulderico received his BSc and MSc degrees in Industrial Chemistry from the University of Rome "La Sapienza" (Italy).

L17 – FRIDAY 24/3: Photovoltaic energy conversion: from the basics to opportunities of direct storage

This lecture will provide the student with some initial general concepts of photovoltaic (PV) energy conversion, moving from the description of the production process and working mechanism of 1st gen Si-based solar panels, followed by a description of the standard characterization methods for these devices. Then, current trends in last generation PV will be discussed, with special emphasis on metal halide perovskite solar cells (PSCs). An overview will follow on how PV and energy storage can be (directly) integrated, to ensure an efficient conversion and accumulation of solar energy. In this regard, I will explain the aims of the H2020-FET-PROACTIVE project "LIGHT-CAP".



Prof. Teresa Gatti, Politecnico di Torino – IT

Associate professor at the Department of Applied Science and Technology. Previously, she was postdoc at the University of Padova (Italy) and junior research group leader at the Center for Materials Research of the Justus Liebig University in Giessen (Germany). She is a chemist and holds a PhD in Materials Engineering from Politecnico di Milano. Her research focuses on the development of new nanomaterials for energy-related applications. Since 2022, she is PI in the ERC Starting Grant project "JANUS-BI", aiming at developing highly asymmetric 2D material inks for the production of photovoltaic and photoelectrochemical/photocatalytic nano-architectures.