Giampaolo Lacarbonara

E-mail: giampaol.lacarbonar2@unibo.it

Date and place of birth	30/12/1994, Noci (Ba), Italy
Sex	Male
Nationality	Italian
Address	Via Coraglia 22, 40026, Imola (BO), Italy

Current position and education

01/11/2022- to date **Post-doctoral researcher**

Department of Chemistry "Giacomo Ciamician" – LEME "Laboratory of Electrochemistry of Materials for Energetics"
University of Bologna (Italy)
Prof. Catia Arbizzani
Topic: New materials and methodologies for electrochemical storage of energy from renewable sources.
Activity: The activities were carried out in the field of in situ and operando measurements on lithium electrodes in liquid electrolytes and batteries employing solid-state electrolyte for next generation batteries.

01/11/2019- 31/10/2022 **PhD in Nanoscience for Medicine and Environment**

Department of Chemistry "Giacomo Ciamician" – LEME "Laboratory of Electrochemistry of Materials for Energetics"
University of Bologna (Italy)
Supervisor: Prof. Catia Arbizzani
Final mark: Excellent
Topic: Study of materials and interphases for electrochemical storage of energy from renewable sources.
Activity: The work was mainly devoted to investigating interfaces in various energy storage systems. In lithium-ion, the effect of lithium-ion insertion on the volumetric stability of the electrodes and gas evolution was explored on the anode side by in-situ dilatometry. Carbon/MO_x hybrid anodes derived from CO_2 capture were studied as sustainable anodes for the next lithium-ion generation through a comprehensive characterization to understand their features (thermogravimetric analysis, spectroscopic and diffractometric techniques). Copper-based redox flow batteries were explored in all their components. This results in the optimization of the electrodes, the investigation of the electrolytic composition and the development of a new methodology for evaluating membranes and sensors. In addition, interphase optimization for metal anodes (e.g., lithium) is being investigated in terms of performance and methodology.

01/15/2022- 31/07/2022 **Research internship**

Department of Physics, division of Material Physics, Chalmers University of Technology, Gothenburg (Sweden)
Supervisor: Prof. Aleksandar Matic
Topic: Operando experiments on metal anodes for next-generation batteries.
Activity: Operando experiments on metal anodes for next-generation batteries. In the framework of next generation batteries based on metal anodes, operando experiments allow to study processes without affecting the metal surface composition. In particular, the attention was focused on Lithium metal and Potassium metal deposition-stripping electrochemical processes with in-operando techniques. In lithium metal cell was studied the influence of the electrolyte on the metal interphase

Bologna**, 05/09/2023**

by operando Raman spectroscopy. In potassium metal cell, differences in the microstructures of potassium during deposition-stripping cycles varying the electrolyte composition was observed by operando X-ray Tomographic Microscopy at the beamline ANATOMIX of the Synchrotron Soleil.

05/10/2017-18/10/2019 **MSc in Photochemistry and molecular materials**

Department of Chemistry "Giacomo Ciamician" – CLAN "Center for Light Activated Nanostructures" CNR ISOF Bologna
University of Bologna (Italy)
Topic: "Photoactive rotaxane as on/off switching of mechanical planar chirality"
Supervisors: Prof. A. Credi, Dr M. Baroncini
Final mark: 110/110 cum laude
Activity: Synthesis and characterization of a [2] rotaxane, based on crown ether-ammonium recognition, that comprises a C_s-symmetric macrocycle and azobenzene units. Such a system exhibits a photoactivated mechanical planar chirality with the possibility to control the ratio between the enantiomeric species generated upon photoirradiation with polarized light. The supramolecular molecules were fully characterized by NMR spectroscopy (^{1}H, ^{13}C, ^{19}F, COSY, HSQC, HMBC, NOESY) and photophysically by UV-vis spectroscopy and emission spectroscopy evaluating the yield of the azobenzene units' isomerization and the emitting properties of the pyrene moiety of the crown-ether. The synthetic route requires the application of Schlenk techniques.

21/09/2013-09/03/2017 **BSc in Chemistry and material chemistry**

Department of Chemistry "Giacomo Ciamician"
University of Bologna (Italy)
Topic: "Synthesis and characterization of fluorophores-radicals system in nanostructured host"
Supervisors: Prof.ssa N. Zaccheroni, Dr D. Genovese
Final mark: 107/110
Activity: Design, synthesis, and characterization of organized nanostructured systems in which energy transfer between radicals and organic fluorescent molecules quench the luminescence. The synthesis of nanoparticles was performed by a reverse microemulsion method, and the characterizations includes Dynamic Light Scattering (DLS), UV-vis spectroscopy, emission, and excitation spectroscopy, Time Correlated Single Photon Counting (TCSPC) and, fluorescence anisotropy. Photophysical techniques were powerful to investigate the behaviour of these materials in the presence of a reducing agent (ascorbic acid) allowing us to monitor changes in fluorescence as the ascorbate concentration varied.

2013 High school leaving qualification in scientific studies.
Liceo Scientifico Tecnologico "Ettore Majorana", Martina Franca (Italy)
Final mark: 100/100

Bologna**, 05/09/2023**

Research experience

SCANNER State of **C**harge **AN**d bala**N**ce s**E**nso**R**
PI: Giampaolo Lacarbonara
Bando "AlmaValue": Scouting dei risultati di ricerca dell'Alma Mater e supporto alla valorizzazione a mercato
Status: Project evaluated eligible but not funded.
In redox flow batteries, this project aimed at increasing the Technology readiness level (TRL) from TRL2 to TRL 4. During the validation phase in the laboratory, the prototyping and optimization phases of the system will begin. The two sensor units are designed to reduce their size and decrease the electrolyte flow into the sensor to decrease the energy impact on the redox flow cell. The 3D-printed components should withstand corrosive environments and be inserted into the hydraulic circuit of the redox flow cell via a low-flow fluidic system. An ideal SoC monitoring system could independently operate SoC measurements on the anolyte/catholyte, identifying and quantifying the earliest stages and extent of problems. Here we propose an approach to also monitor the negative half-cell SoC efficiently, which can be used other RFB chemistries in sensing the cell unbalance.

Co-PI Sensinline Ecosister – Spoke 2 National Recovery and Resilience Plan (NRRP),
In the framework of the all-copper redox flow battery (CuRFB), we have investigated the distribution of the different copper chlorocomplexes in an acidic aqueous solution using spectroscopic techniques. In Ecosister, we'll create a sensor for the operando evaluation of the state of charge (SoC) of the CuRFB and other RFBs based on VIS-NIR absorbing electrolytes at TRL2. The objective of this project is to collaborate with an industrial partner to increase up to TRL6, developing a demonstrator of the sensor.

Carbonaceous materials from captured CO_2
In collaboration with the National Institute of Physics and Biophysics of Tallin and UP Catalyst, carbonaceus materials and carbon-MnOx composite obtained from molten salt carbon capture and electrochemical transformation (MSCC-ET) were investigated as sustainable battery materials. This work set the groundwork for the **EIT Raw Materials European Project CO_2 Carbon**.

EIT Raw Materials European Project CO_2 Carbon (project No. 21081)
CO_2Carbon is a 2-year European project aimed to upscale the innovative technology that turns industrial exhaust CO_2 into sustainable carbon nanomaterials and graphite for the electric vehicle batteries. An automated pilot shipping container will be built, which absorbs 10 tons of industrial exhaust CO_2. Then, the synthesised carbon will be purified and will undergo the quality control. 2700 kg of carbon nanomaterials/graphite will be produced, which will be used for green EV batteries. The activities regarded the application of such carbon allotropes as active material and/or conductive additive in the preparation of electrodes tested as anode in lithium-ion batteries.

CUBER - Copper-Based Flow Battery for Energy storage Renewables Integration H2020 - LC - BAT_2019 [2020-2024]
The Cuber project intends to optimize an all-copper redox flow battery (CuRFB), that highlights simplicity, modularity, environmental safety, and market appealing. Firstly, the study focuses on the electrochemical characterization and optimization of the materials and the compositions of the core components of the CuRFB system: the electrodes, the electrolytes, and the separators. Electrodes were modified and characterized by electrochemical techniques (voltametric techniques, impedance spectroscopy, galvanostatic techniques), by Raman spectroscopy and, by X-ray Photoelectron Spectroscopy (XPS). Electrolytes were evaluated by voltametric techniques as well as spectroelectrochemical measurements and test with the rotating disk electrode for the diffusion coefficient evaluation. Separator characterization consist of permeability test and a new design method with Scanning ElectroChemical Microscopy.

Accordo di Programma Ministero dello Sviluppo Economico - ENEA
Piano Triennale di Realizzazione 2019-2021 - II annualità
Project: 1.2 "Sistemi di accumulo, compresi elettrochimico e power to gas, e relative interfacce con le reti"
Work package: "WP1 - Accumulo elettrochimico"
Activity area: LA77 - Caratterizzazione dell'interfase Li/elettrolita in cella completa
To improve the deposition and stripping of lithium metal and thus reduce the formation and growth of dendrites, the use of additives in various electrolyte systems was evaluated. This were studied in combination with ex-situ treatment on the surface of lithium metal using different methods to create an artificial SEI that can also inhibit dendritic growth, increasing the safety and service life of the cell, was also investigated.

Bologna**, 05/09/2023**

Cyclic voltammetry, impedance spectroscopy and charge-discharge cycles measurements were performed at different current densities. In-situ TEM measurements were designed to evaluate the effect of additives on the change of the electrode/electrolyte interphase and the reaction mechanism of the ammonium salt additive.

Activity area: LA62 - Caratterizzazione dell'interfase Li/elettrolita, nel sistema elettrolitico ottimizzato, con diversi separatori.
The University of Bologna's task for activity LA62 was to try to obtain a protective layer on lithium with a process that could be easily reproduced even on a large scale and at low cost and also, in this case, avoiding the use of chemical agents that are hazardous to health and the environment. Effects of these modifications were evaluated electrochemically and by in situ electrochemical dilatometry.

Accordo di Programma Ministero dello Sviluppo Economico - ENEA
Piano Triennale di Realizzazione 2022-2024
Project: 1.2 "Sistemi di accumulo, compresi elettrochimico e power to gas, e relative interfacce con le reti"
Work package: "WP1 - Accumulo elettrochimico"
Activity area LA23: "Advanced and sustainable electrolyte and separators for lithium-ion and lithium metal cells"
Preparation of stable, safe electrolytes capable of improving electrode performance (liquid, solid, quasi-solid, composite, based on ionic liquids or electrolytes in an aqueous environment) and synthesis of innovative separators (e.g. electrospun polymeric separators).

Third mission – Collaboration with companies

Marposs SpA – Development of an in situ electrochemical dilatometer
Through a collaboration with Marposs S.p.A, I tested their novel apparatus for thickness variation recording during cycling. In-situ electrochemical dilatometry studies were performed on the graphite interphase in two different electrolytes by cyclic voltammetry, Raman spectroscopy and scanning electron microscopy. In ethylene carbonate- dimethyl carbonate-based electrolyte, I investigated the lithium-ion insertion-deinsertion and evaluated solid electrolyte interphase (SEI) formation. In propylene carbonate-based electrolyte, the exfoliation of the graphitic layers was evaluated as the eventual gas formation. Also, the thickness variation of cathodes for lithium-sulphur batteries was investigated by in-situ dilatometry during galvanostatic charge-discharge cycling. Further optimization of the dilatometric system is still in development.

Pietro Galliani SpA – Test and characterization of new bipolar current collectors
The collaboration verted on the realization of electrodes using your current collectors (LFP for the cathode and graphite or lithium metal for the anode), either bipolar or single for better performance comparison. For testing the electrode, a conventional polymeric solid electrolyte was prepared. All the components were used to assemble two-electrode cells for electrochemical evaluation of the performance of bipolar versus single electrodes by means of galvanostatic charge and discharge measurements and electrochemical impedance measurements.

Mentoring activity

09-2022- to date	Academic tutor in the course of "Electrochemical Systems for Energy Storage and Conversion", MSc Photochemistry and Molecular Materials, University of Bologna
2019-2021	Member of the examination commission and laboratory tutor in the course of "Electrochemical Systems for Energy Storage and Conversion", MSc in Photochemistry and Molecular Materials
2020-2021	Member of the examination commission in the course of "Elettrochimica T", BSc in Chemistry and Biochemistry Engineering

Laboratory supervisor of Visiting MSc student from Science Sorbonne University

05/2023	Flavie Cassaro-Hua "Bipolar current collector for new solid-state lithium-ion batteries".

Bologna**, 05/09/2023**

Co-supervisor of MSc student in Chemistry:

10/2021 Nicoló Albanelli "Spectroelectrochemical characterization of copper chloride complexes formed in electrolytical solutions used in redox flow batteries".

Co-supervisor of BSc students in Chemistry and Biochemistry Engineering:

03/2022 Giulia Nicoletti "New separators for advanced lithium-based batteries"

12/2021 Sebastiano Chini "Graphitic carbon from CO_2 for sustainable Li ion battery anodes"

07/2020 Alessia Franceschini "Carbonaceous materials from bio-waste as anodic material in Na-ion batteries".

Training

21-25/02/2022 **"Chess 2021" online school**
School on conventional and high-energy spectroscopies for inorganic, organic and biomolecular surfaces, and interfaces

09-14/11/2020 **"Aldo Armigliati" SEM School 2020**

Grant and awards

27/01/2023 **"Engitech Technologies" prize for PhD thesis**
Division of electrochemistry – Italian Society of Chemistry (1000 € + 300 € refund for GEI2023 conference)

27/01/2023 **Best Oral presentation at IWES 2023 conference**
Gisel network (250 €)

12/07/2022 **Marco Polo Program for international mobility**
University of Bologna (3450 €)

21/02/2022 **School grant**
Division of electrochemistry – Italian Society of Chemistry
Chess 2021 online school (75 €)

Affiliation

2020-to date Member of the Italian National Interuniversity Consortium for Materials Science and Technology - INSTM

2020- to date Italian group for electrochemical energy storage – GISEL

2019- to date Member of the International Society of Electrochemistry

2019- to date Effective member of the Division of Electrochemistry of the Italian Chemical Society - SCI

Dissemination

29/09/2023 **Selected participants at the European Reseacher's Night 2023, "**Unity is strength… and energy".

16/11/2023 **Selected Seminar from the Academy of Sciences of Bologna Institute**, Top ten in Science - "Safety, Sustainability and Comfort: the goals of the batteries in the energetic transition**".**

Bologna**, 05/09/2023** 

21-22/11/2018 **Molecular machines days - "From laboratory curiosities to the Nobel Prize. The journey of nanomachines"**: During this outreach event carried out at the department of chemistry "Giacomo Ciamician" (Bologna, IT), I participated and contributed to the organization of the overall event, took care of filming, security, promotion of the event and presentation of the three 2016 Nobel laureate Prof. Sir Fraser Stoddart, Prof. Ben Feringa and Prof. Jean Pierre Sauvage.

Responsible of the website and social media communication for the LEME "Laboratory of Electrochemistry of Materials for Energetics"

Project reports

Report for ENEA: Ricerca di Sistema Elettrico RdS/PTR2019, C. Arbizzani, M. Rahmanipour, G. Lacarbonara, A. De Marco, Caratterizzazione dell'interfase Li/elettrolita, nel sistema elettrolitico ottimizzato, con diversi separatori. 12/2020.

Report for ENEA: Report Ricerca di Sistema Elettrico RdS/PTR2021, C. Arbizzani, L. Bargnesi, G. Lacarbonara, D. Di Cillo, Caratterizzazione dell'interfase Li/elettrolita in cella completa, 12/2021.

Presentation at conferences

17-21/09/2023 **Invited contribution for the "Engitech Technologies" prize for PhD thesis at Giornate dell'Elettrochimica Italiana (GEI) 2023**,
Oral: G. Lacarbonara, "Study of materials and interphases for electrochemical storage of energy from renewable sources".

03-08/09/2022 **Oral presentation in 74rd International Society of Electrochemistry annual meeting,**
Oral 1: C. Arbizzani, G. Lacarbonara, D. Di Cillo, L. Bargnesi, J. Rizell, M. Sadd, A. Matic, "Operando and In Situ Investigations for Deciphering Lithium Metal-Electrolyte Interphase Modification by Unconventional Additives"

20/05-02/06/2023 **Invited speaker at 2023 E-MRS Spring Meeting & Exhibit in Strasbourg (France)**, G. Lacarbonara, D. Di Cillo, L. Bargnesi, J. Rizell, M. Sadd, A. Matic, C. Arbizzani, "Effect of ammonium and tetraalkylammonium hexafluorophosphates additives on Lithium metal-electrolyte interphase".

20/05-02/06/2023 **Poster presentation at 2023 E-MRS Spring Meeting & Exhibit in Strasbourg (France)**, P.C Ricci, S. Porcu, G. Lacarbonara, C. Arbizzani, "Raman Spectroscopy for Monitoring Residues in Copper-based Redox Flow Batteries".

10-14/04/2023 **Poster presentation at 2023 MRS Spring Meeting**, P.C Ricci, S. Porcu, G. Lacarbonara, C. Arbizzani, "Raman in Situ-monitoring of concentrated solutions for Copper-based redox flow batteries".

25-27/01/2023 **Contributions at Second Italian Workshop on Energy Storage – IWES2023**,
Oral: G. Lacarbonara, L. Bargnesi, D. Di Cillo, C. Arbizzani, "Tetraalkylammonium salts for a stable lithium metal-electrolyte interphase" awarded as Best Oral Presentation.
Poster: S. Tombolesi, N. Zanieri, G. Lacarbonara, L. Bargnesi, M. Mernini, C. Arbizzani, "A sustainable gel polymer electrolyte for solid state electrochemical devices".

22-25/01/2023 **Oral presentation at "30 years of INSTM: past, present and future of the Consortium"**, L. Bargnesi, A. Rozzarin, G. Lacarbonara, S. Tombolesi, C. Arbizzani, "Sustainable modification of chitosan binder for electrodes operating in aqueous electrolyte".

Bologna**, 05/09/2023**

12-16/09/2022 **Oral presentation in 73rd International Society of Electrochemistry annual meeting,** G. Lacarbonara, N. Albanelli, D. Fazzi, C. Arbizzani, "Spectroelectrochemical Characterization and Modeling of Copper Chloro-Complexes Solutions for Redox Flow Batteries".

11-15/09/2022 **Oral presentation at Giornate dell'Elettrochimica Italiana (GEI) 2022**, G. Lacarbonara, R. Petruzzelli, S. De Zio, W. D. Badenhorst, M. Malferrari, L. Murtomäki, C. Arbizzani, S. Rapino, "Scanning ElectroChemical Microscopy method for Cu2+ permeability investigation on membranes for Redox Flow Battery".

20-23/06/2022 **Oral presentation in The First Symposium for YouNg Chemists: Innovation and Sustainability (SYNC2022),** SECM analysis to evaluate the Cu^{2+} ion permeability of different membranes for all copper redox flow battery, R. Petruzzelli, G. Lacarbonara, S. De Zio, W. D. Badenhorst, M. Malferrari, L. Murtomäki, C. Arbizzani, S. Rapino

31/08-04/09/2021 **Oral and Poster presentation in 72nd International Society of Electrochemistry annual meeting,**
Oral: L. Faggiano, G. Lacarbonara, W. D. Badenhorst, L. Murtomäki, L. Sanz and C. Arbizzani, "Electrochemical characterization of carbonaceous electrodes for Copper based redox flow battery"
Poster: G. Lacarbonara, L. Faggiano, C. Arbizzani, "Copper Chloro-Complexes Stability and Dynamics for High Performance Aqueous Redox Flow Batteries".

14-23/09/2021 **Oral presentation in SCI2021**, G. Lacarbonara, N. Albanelli, L. Faggiano, C. Arbizzani A spectroelectrochemical study of copper chloro-complexes for high performance copper redox flow batteries

11/03/2021 **Oral presentation in Flow Camp Next Generation Flow Battery conference and networking event,** G. Lacarbonara, L. Faggiano, S. Rapino, C. Arbizzani, L. Sanz, C. Ricci, L. Murtomäki, W. Badenhorst, J. Rohan, M. Boaventura, J. Cruz, T. Müller, T. Gerber, R. La Gioia, I. Guedea, A. Alvarez, C. Barbu, "Aqueous copper-based flow batteries for renewables integration and sustainable energy storage"

9/03/2021 **Invited seminar at Marposs S.p.a.,** G. Lacarbonara, Experimental validation of the In-situ Electrochemical Dilatometer performed in the Laboratory of Electrochemistry of Materials for Energetics

24-26/02/2021 **Oral presentation in 1st IWES 2021 workshop,** G. Lacarbonara, J. Belcari, L. Lodi, C. Arbizzani, "Gas Evolution in Li-ion batteries revealed by Electrochemical In-Situ Dilatometry".

31/08-04/09/2020 **Poster presentations in 71st International Society of Electrochemistry annual meeting "Belgrade Online"**
Poster 1: G. Lacarbonara, M. Rahmanipour, J. Belcari, L. Lodi, A. Zucchelli, C. Arbizzani, "Investigation of structural changes in different metal ion battery electrodes by in-situ dilatometry".
Poster 2: M. Rahmanipour, G. Lacarbonara, C. Arbizzani, "Lithium Interphase Enhancement for Lithium-Sulphur Batteries"

Bologna**, 05/09/2023**

Publications

1) G. Lacarbonara, M. Rahmanipour, J. Belcari, L. Lodi, A. Zucchelli, C. Arbizzani, "Dilatometric analysis: a powerful tool for testing and improving cell performance", Electrochemical Acta 375 (2021) 137938. https://doi.org/10.1016/j.electacta.2021.137938 (IF: 7.335)

2) G. Lacarbonara, L. Faggiano, S. Porcu, P. C. Ricci, S. Rapino, D. P. Casey, J. F. Rohan, C. Arbizzani, "Copper chloro-complexes concentrated solutions: an electrochemical study", Batteries, 7 (2021) 83. https://doi.org/10.3390/batteries7040083 (IF: 5.938)

3) L. Faggiano, G. Lacarbonara, W. D. Badenhorst, L. Murtomäki, L. Sanz, C. Arbizzani, "Short thermal treatments of carbon felts for copper-based redox flow batteries", Journal of Power Sources, 520 (2022) 230846. https://doi.org/10.1016/j.jpowsour.2021.230846 (IF: 9.794)

4) G. Lacarbonara, C. Arbizzani, S. Chini, S. Ratso, I. Kruusenberg, "Graphitic carbon from CO_2 for sustainable Li ion battery anodes", Mater. Adv., 2022, Advance Article, https://doi.org/10.1039/D2MA00583B (IF: 5)

5) L. Bargnesi, A. Rozzarin, G. Lacarbonara, S. Tombolesi, C. Arbizzani, "Sustainable modification of chitosan binder for capacitive electrodes operating in aqueous electrolytes", ChemElectroChem, 2023, e202201080, https://doi.org/10.1002/celc.202201080 (IF: 4.782)

6) D. Di Cillo, L. Bargnesi, G. Lacarbonara, C. Arbizzani, "Ammonium and Tetraalkylammonium Salts as Additives for Li metal electrodes", Batteries, 9(2) (2023)142, https://doi.org/10.3390/batteries9020142 (IF: 5.938)

7) G. Lacarbonara, N. Albanelli, D. Fazzi, C. Arbizzani, "A spectroelectrochemical study of copper chloro-complexes for high performance all copper redox flow batteries", Manuscript submitted to Elettrochimica Acta 458 (2023), 142514, https://doi.org/10.1016/j.electacta.2023.142514 (IF: 7.335)

8) S. Tombolesi, N. Zanieri, L. Bargnesi, M. Mernini, G. Lacarbonara*, C. Arbizzani*, "A sustainable gel polymer electrolyte for solid state electrochemical systems", Polymers 15 (2023) 15, 3087, https://doi.org/10.3390/polym15143087 (IF: 5)

9) C. Arbizzani, G. Lacarbonara, "From Volta's pile to lithium ion battery: 200 years of energy", ACS Pure and Applied Chemistry (2023), https://doi.org/10.1515/pac-2023-0502 (IF: 1.8) (invited contribution)

10) D. Casey, R. Petruzzelli, G. Lacarbonara, C. Arbizzani, J. Rohan, "The use of bismuth additive to improve copper redox flow battery characteristics", Manuscript in preparation.

11) G. Lacarbonara, M. Sadd, J. Rizell, L. Bargnesi, A. Matic, C. Arbizzani, "Effect of ammonium hexafluorophosphates additive on Lithium metal-electrolyte interphase: an operando Raman study", Manuscript in preparation.

Book Chapter:

L. Sanz, W. D. Badenhorst, G. Lacarbonara, L. Faggiano, D. Lloyd, P. Kauranen, C. Arbizzani, L. Murtomäki, All-copper Flow Batteries, in: C. Roth, J. Noack, M. Skyllas-Kazacos, Part 5: Chemistries other than Vanadium, Flow Batteries From Fundamentals to Applications, Vol. 2, Ch. 38 (2023) 855-873, DOI:10.1002/9783527832767.

Personal skills

Job-related skills

Electrochemistry: voltametric techniques, impedance spectroscopy, galvanostatic techniques, spectroelectrochemical techniques, rotating disk electrode.

Spectroscopy: Raman spectroscopy (also operando), Fourier Transformed InfraRed Spectroscopy, X-ray Photoelectron Spectroscopy (XPS).

Diffractometry: X-ray powder diffraction.

Bologna**, 05/09/2023**

NMR spectroscopy: ^{1}H, ^{13}C, ^{19}F, COSY, HSQC, HMBC, NOESY;

Photophysics: UV-vis spectroscopy, Time Correlated Single Photon Counting (TCSPC), fluorescence anisotropy, circular dichroism spectroscopy.
Porosimetry and Calorimetry: DSC, TGA.

Microscopy: Scanning Electron Microscopy (SEM), Focused Ion Beam-SEM, Transmission Electron Microscopy (TEM), in-situ TEM, X-ray Tomographic Microscopy (XTM) with Synchrotron radiation, Scanning ElectroChemical Microscopy (SECM).

Organic and inorganic syntheses, purification process of chemicals, electrode and electrolyte preparation, cell assembly in inert atmosphere.

Software skills Microsoft Office tools, Linux (basic); ChemBioDraw; Origin and Sigmaplot; MestReNova (NMR data processing and analysis); EClab (electrochemistry); graphic softaware (Adobe Illustrator and Photoshop).

Language skills

Scale: 1-5 (5= Max).

	Writing	Reading	Speaking
Italian	5	5	5
English	4	5	4
Spanish	3	4	3

Autorizzo il trattamento dei miei dati personali ai sensi del GDPR e del Decreto Legislativo 30 giugno 2003, n. 196 “Codice in materia di protezione dei dati personali” ai fini di attività di Ricerca e Selezione del Personale e contatti lavorativi.

Bologna**, 05/09/2023**