Shaping Energy for a Sustainable Future

Institut de Recerca en Energia de Catalunya (IREC)

Gabriela Espinosa (gespinosa@irec.cat)

Areas of expertise

Characterisation, fabrication, assembly and testing

1. **Electrode and battery materials characterisation:** The physiochemical properties of the cell components (carbon, binders, active materials, electrolytes, etc..) can be characterised using a large spectrum of techniques, including XRD, SEM, TEM, Raman spectroscopy, XPS, UV-vis spectrophotometry, AFM, N2-physisorption, thermogravimetric analysis, ellipsometry, PSD, ICP, AC impedance spectroscopy and conductivity measurements (4- and 2- point).
2. **Electrode fabrication and cell assembly:** Standard activities performed at IREC to evaluate new components and the effect of impurities, including new electrolyte formulations. Electrodes from fresh or recycled materials can be fabricated using the Doctor Blade technique and calendaring to mimic commercial high-loading electrodes. IREC can assemble specific coin cells: half-, symmetric-, 3-electrode and full-cells for the electrochemical characterisation of electrodes and cell components.
3. **Electrochemical testing:** IREC has several cell and battery testers and potentiostats with > 100 coin cell channels available, some installed inside a glove box for electrode characterisation in inert conditions. Galvanostatic and potentiostatic techniques are combined with ac impedance spectroscopy using equivalent circuit analysis to identify the main electrical contributions. Also, the diffusivity and conductivities of cell components can be evaluated and correlated to post-mortem studies.

Areas of expertise

4. Ageing tests: Battery cell (≤30 Ah) testing can also be conducted at high temperatures using an ACS/ATT climate chamber model FM600 in the temperature range of -35/100 ˚C and relative humidity range of 10-98%.

5. Post-mortem characterisation: End-of-life battery cells can be dismantled and components investigated to identify degradation mechanisms. For post-mortem analysis the following techniques are available: XRD, SEM, TEM, Raman spectroscopy, XPS, UV-vis spectrophotometry, AFM, chemisorption, N2-physisorption, thermogravimetric analysis, ellipsometry, PSD and ICP.

Modelling, data acquisition, hardware in the loop and automation

1. **Modelling and control systems:** Including SoX estimators and indicators (SoS, SoF, RUL,..) and modelling of degradation mechanisms.
2. **Sensors:** At cell level to correlate digital version with physical one, data transmission, calibration, adaptive modelling, early failure detection,…
3. **AI and Machine Learning:** Stablish data space framework, generate dynamic database, training and validation of AI based methodologies to enhance system design and generate accurate projections of performance providing assistance to decision making.
4. **XiL and automated testing:** With battery cells and all formats, combining multi-physics models, data driven approaches, sensors and real-time calculations with HPC.

Areas of expertise

Sustainable Energy Technologies: Life Cycle Assessment, Circular Economy & Eco-Design:

- **Life Cycle Sustainability Assessment** (LCA, LCC, S-LCA) – Ensuring low environmental impact, cost efficiency, and social responsibility.
- **Circular Economy & Eco-Design** – Designing batteries for recyclability, second-life applications, and resource efficiency.
- **Carbon Footprint & Energy Efficiency** – Supporting compliance with EU carbon footprint thresholds and energy-efficient production.
- **Regulatory Compliance with EU Battery Regulations** – Addressing requirements for carbon footprint disclosure, recycled content, supply chain due diligence, and extended producer responsibility (EPR), Digital Battery Passport (data provider).
- **Critical Raw Materials (CRM) Reduction & Recycling** – Supporting low-CRM battery chemistries and sustainable sourcing strategies.
- **Safe and Sustainable by Design (SSbD) for Battery Materials** – Ensuring advanced battery chemistries (LMFP, HLM, Sodium-ion) are non-toxic, low-risk, and resource-efficient.

Interest areas

HORIZON-CL5-2025-02-D2-02 Cost-effective next-generation batteries for long-duration stationary storage

Contributions

Power Systems: Implement calibrated and validated computational models and artificial intelligence methods for cell design and digital validation of performance

ESA-Energy System Integration: SoH assessment and techno-economic assessment, business models for second life and for elongation of first life in vehicles as storage systems in V2X.

IREC

Shaping Energy for a Sustainable Future

Gabriela Espinosa
gespinosa@irec.cat

Board of Trustees

Generalitat de Catalunya

Gobierno de España – Ministerio de Ciencia, Innovación y Universidades – Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

Gobierno de España – Ministerio para la Transición Ecológica – IDAE

Universitat de Barcelona

Universitat Rovira i Virgili

Universitat Politècnica de Catalunya BarcelonaTech

endesa

Naturgy

enagas

Interest areas

HORIZON-CL5-2025-02-D2-06 Fostering the European Battery Ecosystem by Providing Accurate and Up-to-date Information and Stimulating Excellence in the European Battery R&I Community

Contributions