Erick Espinosa-Villatoro, Ph.D.

Materials Scientist | Battery R&D | Advanced Characterization & Failure Analysis
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Summary

Innovative Materials Scientist and R&D Engineer with 9+ years of experience leading advanced analytical characterization, electrochemistry, and root-cause failure analysis for next-generation energy storage and functional materials. Proven expert in operando/in situ X-ray diagnostics (XAS, TXM, XRD), surface science, and Python-driven data automation. Skilled at translating complex chemical, structural, and interfacial diagnostics into actionable materials engineering solutions across academic, national laboratory, and industrial collaborations. Adept at bridging the gap between fundamental materials synthesis and commercial battery performance.

Technical Skills

- **Analytical & Surface Characterization:** SEM, XPS, AFM, Cryo-EM, LALI-TOF-MS (EXUM Massbox), STXM-ptychography, 3D chemical mapping, non-destructive evaluation (NDE).
- **Synchrotron & X-ray Methods:** Operando & ex-situ XAS (μ-XANES, EXAFS), Transmission X-ray Microscopy (TXM), X-ray Diffraction (XRD), μ-XRF.
- **Electrochemistry & Testing:** Cyclic Voltammetry (CV), Electrochemical Impedance Spectroscopy (EIS / DRT analysis), galvanostatic cycling, rate capability, formation protocols.
- **Battery Systems & Chemistries:** Ni-rich cathodes ($LiNiO_2$), Li-metal, Silicon anodes, Sodium-ion ($NaMO_2$), solid-electrolyte interphase (SEI/CEI) stability; coin, pouch, and Swagelok cell assembly.
- **Computation & Data Automation:** Python (NumPy, SciPy, Matplotlib, Imfit), custom spectral fitting, automated data pipeline analysis, multidimensional dataset visualization.

Research Experience

Postdoctoral Scholar 2022 – 2026
Stanford Synchrotron Radiation Lightsource (SSRL), SLAC National Accelerator Laboratory, Stanford University

- Led operando and ex-situ X-ray diagnostics (XAS, TXM, XRD) across multiple battery chemistries, identifying root-cause structural degradation pathways in Ni-rich cathodes to inform the development of more stable, high-energy-density materials.
- Uncovered critical structure-property relationships between cathode dopant chemistry (Co, Mn, Al) and electrochemical stability, generating mechanistic insights to guide next-generation cathode formulation (published in J. Mater. Chem. A).
- Spearheaded advanced multimodal surface and elemental characterization (μ-XRF, μ-XANES, LALI-TOF-MS), building mechanistic models to quantify transition-metal crossover and SEI layer growth in high-voltage lithium systems.
- Engineered custom Python analytical scripts (using NumPy, SciPy, Imfit) to automate the parsing and spectral fitting of complex mass spectrometry and synchrotron datasets, significantly accelerating heterogeneity tracking and diagnostic workflows.
- Directed high-resolution 3D chemical mapping workflows to visualize elemental distributions and structural defects in battery electrodes, collaborating with Idaho National Laboratory (INL) on Li-metal anode surface stability.
- Collaboration in multi-institutional DOE-funded research (including UT Austin, UCLA, INL, and APS) focused on fast-charging protocols, Li-metal stability, and diagnostic tool development; mentored 2 undergraduate interns and 1 Ph.D. student.

Postdoctoral Scientist 2021 – 2022
Instituto de Investigaciones en Materiales, UNAM

- Synthesized $NaMO_2$ (M = Fe, Mn) ceramic materials *via* solid-state and co-precipitation routes for energy storage and high-temperature gas adsorption applications.
- Evaluated kinetic reaction mechanisms (Avrami-Erofeev, Mars-van Krevelen) governing thermal stability and catalytic performance, achieving up to 9.5% CO_2 capture at 800°C and 100% CO conversion at 450°C.
- Conducted rigorous physical and chemical characterization to optimize functional ceramic synthesis parameters.

Doctoral Researcher 2017 – 2021
Benemérita Universidad Autónoma de Puebla (BUAP) & SSRL, SLAC

- Developed novel Na-preconditioning chemical strategies for Silicon anodes, successfully mitigating capacity fade and enhancing SEI interfacial stability in Li-ion battery systems.
- Utilized advanced imaging and diffraction techniques (operando XRD, TXM, and STXM-ptychography) to track non-destructive structural evolution, morphological stress, and phase transformations during cycling.
- Pioneered a 3D relaxation-time analytical methodology to map kinetic lithiation processes and pinpoint localized electrode failure mechanisms.

Education

Ph.D. in Materials Science | Benemérita Universidad Autónoma de Puebla, Mexico 2017 – 2021
M.Sc. in Materials Science | Benemérita Universidad Autónoma de Puebla, Mexico 2015 – 2016
B.E. in Energy Engineering | Universidad Politécnica de Chiapas, Mexico 2011 – 2014

Additional Information

- **Languages:** English (Fluent), Spanish (Native)
- **Selected Publications:** Lead and co-author on multiple high-impact peer-reviewed publications across Journal of Materials Chemistry A, Journal of Electroanalytical Chemistry, Journal of Environmental Management (full list available upon request).