

# Erick Espinosa-Villatoro, Ph.D.

Materials Scientist | Operando/Synchrotron Diagnostics | Battery Degradation Mechanisms  
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## Education

<b>Ph.D., Materials Science</b> , Benemérita Universidad Autónoma de Puebla, Mexico <i>Dissertation: Effect of pre-conditioning of Si anodes by sodiation in their performance in Li-ion batteries.</i>	2017–2021
<b>M.Sc., Materials Science</b> , Benemérita Universidad Autónoma de Puebla, Mexico	2015–2016
<b>B.E., Energy Engineering</b> , Universidad Politécnica de Chiapas, Mexico	2011–2014

## Research & Projects

**(un)doped LiNiO<sub>2</sub> (5% Co, Mn, Al) cathode analysis using synchrotron-based probes** 2022 - Present  
*Postdoctoral Scholar, Stanford Synchrotron Radiation Lightsource (SSRL), SLAC, PI: Johanna Nelson Weker, Ph.D.*

- Personally developed an strategy and applied advanced synchrotron techniques (XAS, TXM, XRD) to study degradation pathways in Ni-rich layered oxides (LNO) systems. Assemble, cycle, and characterize coin and pouch cells across diverse high-Ni chemistries, electrolytes, and formation protocols.
- Led operando and ex-situ experiments to link electrochemical performance, interfacial chemistry, and structural evolution with the dopant-dependent (5% Co, Mn, Al) stability of LiNiO<sub>2</sub>.
- Led and submitted a multimodal TXM/XRD/XAS study showing how targeted doping modulates heterogeneity, reconstruction, and degradation in LiNiO<sub>2</sub>.
- Mentored two interns (SULI program)—one now a Ph.D. student at MIT and another currently applying to graduate school.
- Supervised a Stanford Ph.D. student working on Si-anode degradation using electrolyte-dependent studies.
- Close collaboration with Prof. Manthiram's group at UT Austin to study high-Ni layered oxide cathodes for Li-metal, -ion batteries; and INL, UCLA and APS on DOE-funded programs focused on fast charging, Li-metal stability, and advanced diagnostics.

**Interplay of TM crossover and SEI growth in Li||high-Ni cells** 2023 - Present

- Integrate multimodal analysis—combining synchrotron X-ray diagnostics ( $\mu$ -XRF,  $\mu$ -XANES) with laser ablation laser ionization time-of-flight mass spectrometry (LALI-TOF-MS)—into high-fidelity mechanistic models, improving interpretation of cathode crossover, SEI formation, and failure modes.
- Direct LALI-TOF-MS workflows for high-resolution elemental mapping and trace-species identification in battery electrodes. Building 3D chemical-distribution maps with depth and lateral resolution.
- Meet regularly with EXUM's development team to improve and optimize Massbox performance for battery materials diagnostics.

**Heterogeneity evolution in pouch-cell Li metal anodes** 2024 - Present

- Collaboration with INL team to study the native LiO<sub>x</sub> layer on Li metal anodes with and without brushing process.
- Generating 2D chemical-distribution maps with lateral resolution. Developed a Python workflow for Gaussian-Voigt fitting of Massbox spectra to track heterogeneity of Li-O, Li-C, and Li-H species across the Li-metal surface.
- Used this analysis to show that brushing Li metal produces a more homogeneous native LiO<sub>x</sub> layer across the anode surface.

**NaMO<sub>2</sub> ceramic synthesis and multimodal evaluation for CO<sub>x</sub> capture and Li and Na-ion electrodes** 2021- 2022  
*Postdoctoral Scientist, Instituto de Investigaciones en Materiales, UNAM, PI: Heriberto Pfeiffer Perea, Ph.D.*

- Synthesized and evaluated doped Na ferrites and Na manganates as cathode candidates for Na-ion and Li-ion batteries.
- Synthesized NaMO<sub>2</sub> ceramics (M = Fe, Mn) for CO/CO<sub>2</sub> adsorption and catalytic oxidation.
- First author** study showing that sodium manganates achieve high-temperature CO<sub>2</sub> chemisorption and low-temperature CO oxidation, with optimal performance at an  $\alpha$ -NaMnO<sub>2</sub>:Na<sub>2</sub>Mn<sub>3</sub>O<sub>7</sub>, CO<sub>2</sub> capture up to 9.5% at 800°C, and 100% CO conversion at 450°C, driven by Avrami-Erofeev and Mars-van Krevelen mechanisms.

**Pre-conditioning of Si anodes for Li-ion batteries by sodiation** 2017- 2021  
*Doctoral Student Researcher, Institute of Physics, BUAP, and SSRL, SLAC, PI: Enrique Quiroga-González, Ph.D.*

- Researched electrochemical Na-preconditioning of micrometer-sized Si anodes, performance analyzed using CV, EIS, galvanostatic cycling, and coin/pouch/Swagelok cells to assess structural and electrochemical stability.
- Showed successful Na insertion and formation of Na-Si phases, improved SEI evolution, and enhanced cycling stability, supported by TXM, ex-situ/operando XRD, and STXM-ptychography at SSRL and ALS.
- First author** on a study that used 3D visualization of relaxation times to track lithiation-driven processes in silicon anodes, clarifying key degradation mechanisms in Li-ion batteries.

## Technical Skills

**Synchrotron X-ray (operando & ex situ):**  $\mu$ -XRF,  $\mu$ -XANES, EXAFS, TXM, XRD

**Materials Characterization:** XRD, SEM, LALI-TOF-MS\*, Cryo-EM, AFM, XPS (\*EXUM Massbox super user)

**Electrochemistry:** CV, EIS (DRT), galvanostatic cycling, rate/formation studies

**Battery & Cell Systems:** Li-metal, -ion, Ni-rich cathodes, Si anodes, Na-ion; Coin, pouch, Swagelok; glovebox operation and safety

**Programming:** Python (NumPy, SciPy, Matplotlib, lmfit)

**Languages:** English (Fluent) | Spanish (Native)