EVALS: Enhanced VALidation of advanced battery Supply chains

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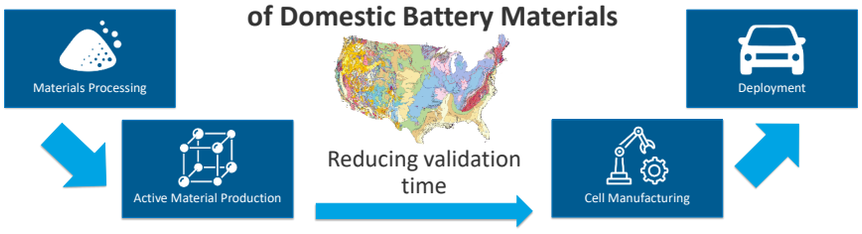
Motivation

- Rapid deployment of electric vehicles (EVs) requires rapid raw material sourcing and precursor production.
- US. Department of Energy has incentivized domestic sourcing and battery manufacturing through recent legislation such as the inflation reduction act and bipartisan infrastructure bill.

EVALS – Accelerating Validation of Domestic Battery Materials



Understanding Domestic & Allied Primary Sources | *National Laboratory-Led Material Consolidation, Acceptance, & Validation* | *Domestic Manufacturing Support*

Vision

- Accelerate the process to bring domestic and allied primary sources of battery materials online, from production to deployment.
- With industry advisement and engagement, bring together stakeholders across the entire supply chain and develop tools to accelerate source qualification.

Project overview

Identified Risks & Needs

- Each geologic source has different impurity levels.
- Time-consuming validation of new sources.
- Low uniformity in purification methods and tolerance levels across materials, producers, and cell manufacturing.
- High-throughput, combinatorial analysis is insufficient and costly.

Applications for Validation Tools

- Location-specific forecasting of impurities and impacts.
- Test matrix reduction methods reduce time and resources for combinatorial, high-throughput approaches.
- Coordinated testing, prediction, and modeling tools.
- Expanded parameter extraction from early data.
- Integrated life and cost tools strengthen links between performance and cost as a function of processing and impurities.
- Transferable insights across materials and cell designs.

Life, Performance and Cost
- Accelerate lifetime predictions to rapidly understand the impact of variations in supply chains caused by varied impurity profiles.
- Impurity removal and performance tradeoffs.

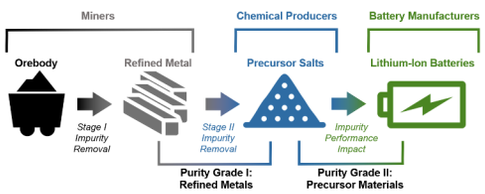
Fully develop a suite of tools that can be directly used by industry to evaluate domestic primary resources and accelerate their path to production to support automotive OEMs.

Source Mapping & Processes
- What materials and what impurities do we need to worry about?
- Select sources and identify most common impurities.

Material Impacts
- Targeted synthesis of materials.
- Physical and electrochemical properties.

Why focus on impurities?

- Determining problem impurities changes access to sources at cost points that impact EV adoption.
  - Supports domestic production and manufacturer access to reliable sources to meet US environmental regulations.
  - Mitigates supply chain national security concerns.
- Impurities may limit performance and change failure path.
  - Removal is a key cost contributor for material production.
- Vary by location and supplier – providing federal support aids both domestic material and cell production.



Understanding impurities provides a direct route to maintain performance while driving down cost.

Project task areas
- *Process Knowledge and Sourcing*
- *Materials*
- *Cell and Electrode Development*
- *Advanced Test Development and Analysis*
- *Models and Prediction*

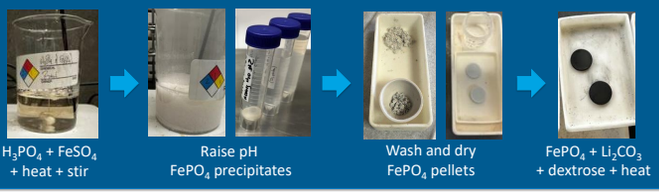
Program goals

- Enhance understanding of key impurity levels and enable the use of all domestic sources.
- Develop advanced methods/procedures to grade materials, processes, and quantify life impacts.
- Know what impurities are and what levels are acceptable based on life and cost.
- Identify methods to rapidly understand cell performance and supply chain impacts as new sources come online.
- Facilitate source validation, so manufacturers have confidence in broad emerging supplies.

Initial results from seedling project at NREL

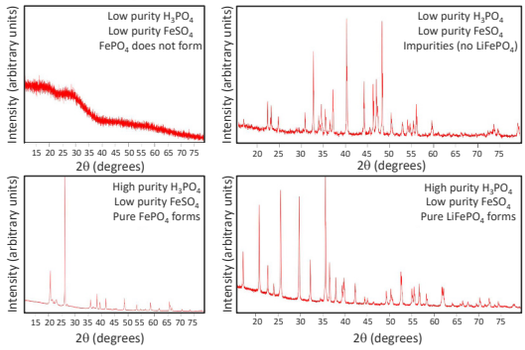
- $LiFePO_4$ is attractive for US domestic manufacturing due to low cost, safety, and the absence of Co and Ni.
- $LiFePO_4$ battery production announced for many planned domestic gigafactories.[1,2]
- $LiFePO_4$ chosen as an example material for seedling project at NREL and initial work in EVALs.

Lab scale simulation of conventional industrial $LiFePO_4$ synthesis process



- Initially synthesized $LiFePO_4$ with low, medium, and high purity H_3PO_4 with low and high purity $FeSO_4$ to simulate varied purity from varied sources.
- Next will expand to introducing targeted impurities based on source analysis.

Precursor purity drastically impacts $LiFePO_4$ synthesis.



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1. https://techcrunch.com/2024/07/20/tracking-the-ev-battery-factory-construction-boom-across-north-america/
2. https://cen.acs.org/energy/energy-storage-/Lithium-iron-phosphate-comes-to-America/101/i4

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