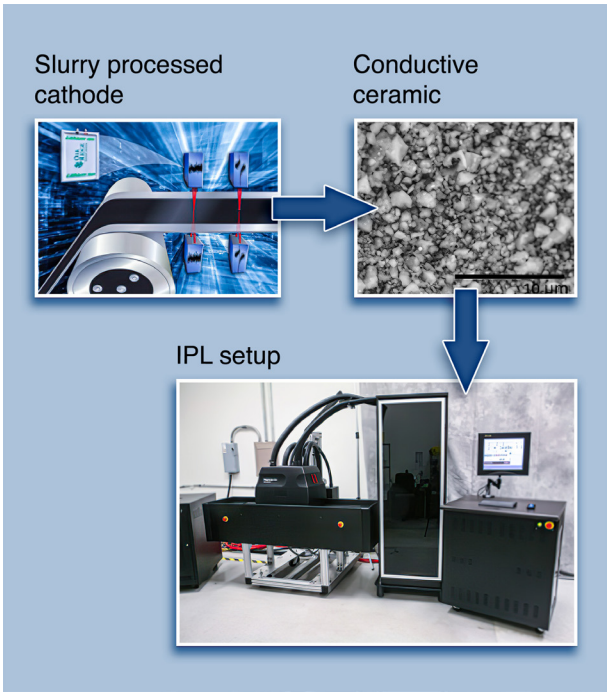
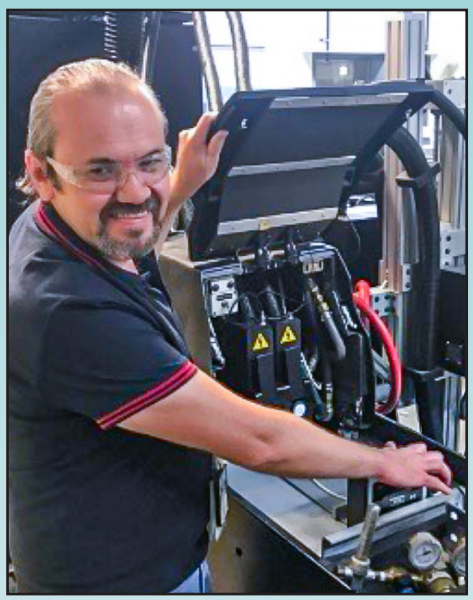
Sintered Composite Electrolyte for Lithium Batteries (SINC-lyte)

Problem: While solid-state lithium batteries promise transformation to significantly higher energy density and inherently safe energy storage systems, their development presents significant challenges. The major component of these batteries is the solid electrolyte, which blocks lithium dendrites, conducts lithium ions, and can be easily integrated into the battery cell structure. As of today, there is no single electrolyte that possesses all three properties.

Solution: Sintered Composite Electrolyte for Lithium Batteries (SINC-lyte) introduces a composite electrolyte that addresses lithium battery challenges by combining properties of several materials. Ion-conducting ceramic is partially sintered to provide a conductive percolative pathway and to serve as a skeleton that is subsequently back-filled with a polymer electrolyte. SINC-lyte can be tape-cast on top of the conventional battery cathode and then partially sintered using pulse light processing. In this way, SINC-lyte is integrated with the cathode, simplifying the battery manufacturing process. Because electrolyte is cast as a thin layer from colloidal suspension, the structure has sufficient flexibility for roll-to-roll processing.

Impact: Robust solid electrolyte is the key element of a solid-state battery with a metallic anode. As of today, there is no example of the integration of solid ceramic electrolyte into a battery, beyond thin-film batteries. SINC-lyte provides a robust composite electrolyte that can be co-manufactured with the cathode in a roll-to-roll manner. This will significantly impact solid-state lithium battery technology maturation, with long-term projected benefits of higher safety and structural rigidity compared to today's liquid electrolyte batteries. Batteries containing SINC-lyte, therefore, can be used as structurally integrated energy storage, making them ideal for applications such as drones and other electric aircraft.





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Dr. Kalnaus is a computational scientist in the Computational Sciences and Engineering Division. He holds doctoral and master's degrees in mechanical engineering from the University of Nevada and Kharkiv Polytechnic (Ukraine), respectively. His work involves both computational modeling and experiments. His research interests include mechanics of materials for energy storage, crashworthiness of batteries in electric vehicles, and solid-state batteries. He holds four patents. He received a 2017 R&D 100 award as a part of the team that developed impact-resistant electrolyte for lithium-ion batteries.

Intellectual Property

"Thin Solid Composite Electrolyte with Zero Interparticle Resistance," Invention Reference Number 201904372; US Patent Application 17/497,023, October 8, 2021

Publications

- M. Palmer, S. Kalnaus, M. B. Dixit, A. S. Westover, K. B. Hatzell, N. J. Dudney, X. C. Chen, "A Three-dimensional Interconnected Polymer/Ceramic Composite as a Thin Film Solid Electrolyte," *Energy Storage Mat.* 26, **2020**, 242–249.

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