MODEL BASED DESIGN OF COMPRESSED LITHIUM-METAL POUCH CELL BATTERY MODULES FOR eVTOL APPLICATIONS

A Master's Thesis Defense in Mechanical Engineering

California Polytechnic State University, San Luis Obispo

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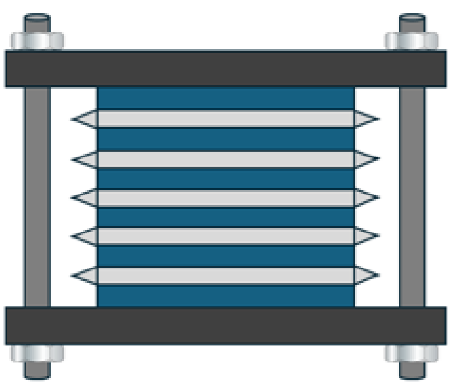
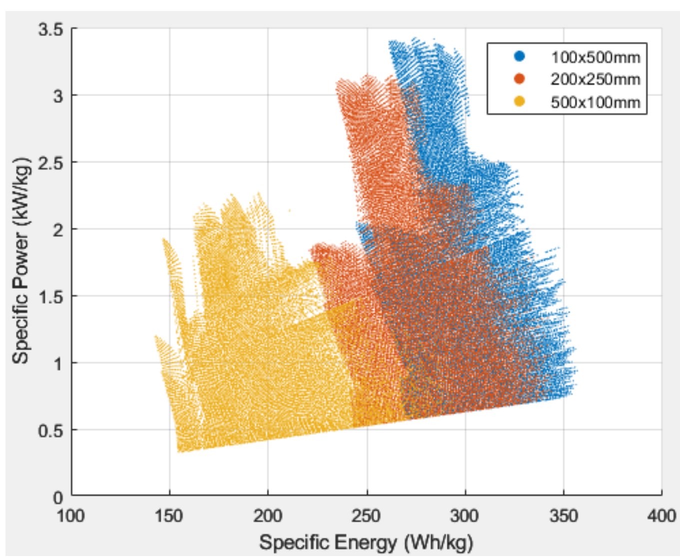
Batteries with higher specific energy and power are essential for extending the range and performance of electric vertical takeoff and landing aircraft (eVTOLs). Anode-free lithium-metal pouch cells offer strong potential at the cell-level but require high compressive pressures to enhance cycle life and discharge performance. These pressures necessitate heavier structural components, reducing packaging efficiency at the module level.

To evaluate this tradeoff, a full-factorial enumeration model was developed to explore viable module designs within a constrained packaging volume. The model scales subsystem masses, enforces design rules and material limits, and accounts for large (~20%) cell thickness changes during cycling.

Results show that modules exceeding 300 Wh/kg and 1.5 kW/kg are achievable with commercially available lithium-metal cells. The study also recommends cell shape optimizations to further improve packaging efficiency. Despite simplifying assumptions, the model provides a practical tool for rapidly identifying optimal packaging strategies and supports the feasibility of these batteries for eVTOL applications.





3:10 PM Thursday, June 12th

Building 13 Room 124b and on Zoom: https://calpoly.zoom.us/j/3779955884