Advanced Thermofluids Optimization, Modelling, and Simulation (ATOMS) Laboratory

Master of Engineering (MEng) Research Project

Title: Predicting thermal runaway propagation in lithium-ion battery systems

Motivation:

The adoption of lithium-ion battery (LIB) technologies has increased rapidly over the past decade, partly stemming from the need to pursue cleaner energy storage solutions. The automotive industry is aggressively pushing for the global adoption of LIBs, with leading automakers racing to develop LIB technologies to enable the next generation of LIB-powered electric vehicles (EVs). Despite the clear advantages of LIBs, critical challenges affecting battery reliability, lifespan, and safety are still impacting the widespread adoption of EVs.

A major safety concern with LIBs is battery thermal runway which describes an uncontrolled exothermal process involving ignition, explosion, and harmful gas emission. Thermal runaway is typically caused by abusive operating conditions such as overcharging, overheating, or nail penetration; it usually originates in a single cell surrounded by other cells in a battery pack. In the worst-case scenario, the temperature increase caused by an initial thermal runaway event results in rapid heat propagation that triggers new events in adjacent cells, leading to a catastrophic chain reaction. This MEng project will help ATOMS Lab develop a first-of-its-kind hierarchical LIB thermal runaway propagation model of broad applicability across multiple LIB pack architectures used in commercial EVs and stationary energy storage systems.

Objective:

The overarching goal of this MEng project is to develop cell-to-pack hierarchical models and leading-edge simulation tools for predicting thermal runaway propagation in LIB systems for EVs and other energy storage systems of relevance for ATOMS Lab's industry partners. These thermal runaway models and simulations will partially eliminate the need for costly and time-consuming battery fire tests and accelerate the design optimization process of fault-tolerant energy storage systems.

Required Experience/Skills:

In-depth understanding of thermal transport phenomena and battery electrochemistry. Strong foundation in multiphysics computational modelling, simulation, and model validation. Experience with battery systems and battery testing equipment would be an asset.

To Apply:

Submit CV, unofficial transcripts, and one paragraph describing your interest in the project to Prof. Cristina Amon (cristina.amon@utoronto.ca)