Modeling for understanding and preventing cascading thermal runaway in battery packs

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Internally, batteries typically have both fuel and oxidizer, making them a premixed system subject to thermal runaway. Lithium-ion batteries are particularly desirable for energy storage applications because of their relatively high energy and power density. Within lithium-ion batteries a series of exothermic and gas-generating reactions can take place as temperatures rise leading to thermal runaway. Measurements have elucidated the key processes and calorimetry has identified approximate heat release rates in lithium-ion cells for a range of chemistries. An important challenge is to extend laboratory and single-cell results to large scales involving potentially thousands of cells together with geometric complexity. The balance between the heat and electrical energy release and their dissipation is important in determining the possibility that an isolated cell-level event will lead to a cascading failure with more significant consequences. This talk will discuss both fundamentals of ignition behavior associated with cascading failures and the use of computational fluid dynamics (CFD) to predict the evolution of thermal runaway events. In particular, we discuss the ability to consider a range of material and thermal characteristics of the system through modeling in order to reduce the costs associated with large-scale tests and experiments.

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