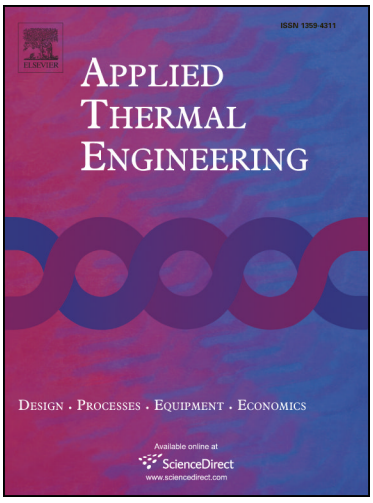

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Measurements and Modeling to Determine the Critical Temperature for Preventing Thermal Runaway in Li-ion Cells

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Abstract

Li-ion cells are widely used for electrochemical energy conversion and storage, but suffer from safety problems due to overheating. At elevated temperatures, the cell enters a state of thermal runaway involving multiple heat-generating decomposition reactions that eventually lead to fire and explosion. Understanding the nature of thermal runaway, specifically the highest temperature that a cell can safely withstand, is critical for improving cell safety. This paper presents an experimentally validated method to predict the critical temperature based on the thermal balance between temperature-dependent heat generation, thermal conduction in the cell and heat dissipation on the cell surface. It is shown that for a single reaction case, the critical temperature can be determined from the root of a non-linear, transcendental equation involving parameters that characterize these processes. A computational model for a more realistic but complicated case of multiple reactions with reactant consumption is also presented. The predicted critical temperature is found to be in good agreement with experimental measurements