Modeling, Estimation, and Control of Lithium ion Batteries

One of the key challenges for adoption of electric vehicles is the cost of batteries. Battery packs for automotive vehicles are typically oversized, by as much as 30%, to allow for both uncertainty in the usage requirements and degradation of the cells over time. A better estimation of the cell state in real-time and with optimal placement of sensors in commercial packaging constraints would increase the battery utilization and inform higher level energy- and power-management systems. Consumer concerns such as range anxiety can be alleviated though better estimates of battery states and parameters coupled with predictive models of battery performance over the life of the cell.

Expansion of the lithium ion battery active materials during charging (lithiation) and thermal cycling leads to mechanical degradation, particle cracking and de-lamination of the electrodes resulting in capacity loss and growth in internal resistance. Therefore models of the concentration gradients and resulting expansion as a function of temperature and C-rate are needed. Given these coupled Multiphysics models estimation techniques need to be developed which consider the mechanical response of the electrode, in addition to traditional current, voltage and temperature measurements to improve the accuracy of State of Charge (SOC) and State of Health (SOH) estimation. The objective of this open session is to highlight the state of the art in battery modeling and control for automotive systems.

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