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# Optimal Control of Li-Ion Batteries Based on Reformulated Models

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Electrochemical Energy Storage devices like lithium-ion batteries are the preferred candidates for storage of energy in a variety of small and large scale applications. Several problems persist with Li-ion batteries including underutilization, capacity fade, and thermal runaway caused by operation outside the safe window [1]. These problems can be addressed by using a systems engineering based approach by performing model based design and optimization [2-3] using a battery model that accurately describes the system dynamics and at the same time is computationally inexpensive [4-5].

After the battery is manufactured, the variables that are available for manipulation are very limited and it is especially important to make the best utilization of these variables during battery operations. A physics based battery reformulated model was employed within a dynamic optimization technique to compute a time-varying charging profile that improved battery performance by storing more energy within a stipulated amount of time [6-7]. There also have been past efforts on maximizing life of a battery using simple single particle models for evaluating optimal charging profiles [8].

This talk will present results of optimal control of batteries, where optimum charging profiles will be obtained by including mechanisms for capacity fade. The objective would be to extend the life of the battery while operating it with a specific protocol. The dynamic optimization scheme will also include temperature constraints, which will enable to extend the life of the battery and make it safer for operation, by controlling the sudden rise in temperature that could cause serious damage to the battery. Apart from the commonly used capacity fade mechanisms, dynamic optimization studies to reduce mechanical stress effects within the battery would also be studied and the optimal charging profiles for specific performance objectives will be presented.

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