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## Understanding and Improving Lithium Ion Battery Degradation: Modeling and Experiments

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Lithium ion batteries are under intense, worldwide research for improvement in durability and energy density for a wide range of applications, including electric and hybrid electric vehicles. Clear understanding of the battery capacity fading can lead to precise cycle-life prediction of batteries. For advanced lithium ion batteries with high energy and power performance, different aspects of lithium ion batteries such as novel electrode materials, improved electrode designs, Stabilizing electrolyte additives etc. are under high attention. When lithium is inserted in either the positive or negative electrode, the electrode material experiences mechanical stresses. Diffusion- induced stresses (DISs) can therefore cause the nucleation and growth of cracks leading to mechanical degradation of electrodes. We develop several mathematical models to study the behavior of diffusion induces stresses and effects of electrode shape, size, concentration dependent material properties, pre-existing cracks, phase transformations, operating conditions etc. on the diffusion induced stresses.

Instability of commonly used electrolytes at the operating potentials leads to chemical degradation at the electrode surface. We study coupled chemical-mechanical degradation of electrode materials to understand the capacity fading of the battery with cycling. Chemical degradation can be decreased using electrolyte additives. We study the effect of electrolyte additive VC on parasitic reactions in Graphite/Lithium Nickel Manganese Cobalt Oxide (NMC) cells. Mechanical degradation can be avoided by use of novel electrode material such as liquid metal electrodes. We demonstrate that liquid metal electrodes can act as self-healing electrodes.

### Biography

Rutooj Deshpande has completed his Ph.D at the age of 25 years from University of Kentucky and is currently an electrochemical engineer postdoctoral fellow at Lawrence Berkeley National Laboratory, Berkley. His research focus is lithium ion battery degradation and improvement. He was the recipient of Graduate Excellence Material Science Diamond Award offered by American Ceramic Society (2011). He is on the reviewer panel of several journals Including Proceedings of National Academy of Science, Journal of Applies Physics, journal of Electrochemical Society.

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## Chemically engineered nanoparticles and nanowires for energy and health applications

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Chemistry in the past few decades has played a major role in the convergence of life, physical and engineering sciences leading not only to simple collaboration among the disciplines but to a paradigm shift based on true disciplinary integration. Implications of chemistry as an innovation motor are now visible for knowledge leap forward in various sectors such as biomedical engineering, energy, health and security. Inorganic nanostructures inherit promises for substantial improvements in materials engineering mainly due to improved physical and mechanical properties resulting from the reduction of microstructural features by two to three orders of magnitude, when compared to current engineering materials. This talk will present how chemically grown nanoparticles, nanowires and nanocomposites of different metal oxides open up new vistas of material properties, which can be transformed into advanced material technologies. The examples will include application of superparamagnetic iron oxide nanoparticles for drug delivery applications, vapour phase synthesis of nanowires and development of nanowire-based devices. The successful synthesis, modification and assembly of nanobuilding units such as nanocrystals and wires of different materials have demonstrated the importance of chemical influence in materials synthesis, and have generated great expectations for the future. The design of nanomaterials as possible anode/cathode materials for energy storage especially to meet the requirement for future generations of rechargeable lithium ion batteries will be discussed to demonstrate that new material integration technologies and and multi-material architectures can improve the functional performance.

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