MECHANICAL ENGINEERING SEMINAR

"Solid State Energy Storage: Technology across Sectors"

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Abstract: Critical, imminent changes in the world energy portfolio have amplified pressure on development of advanced energy storage technology, for the grid, automotive and consumer electronics sectors. Technology advances are not only required to enable the largest entry of people to the middle classes in human history, but also to avert disastrous consequences of irrevocable climate change and environmental harm. Present Li-ion batteries (LiB) cannot meet these burgeoning needs, for reasons of cost, performance and safety. Present manufacturers of the incumbent technology all employ liquid electrolytes and lamination processing in highly conserved plant designs, producing cells that are not differentiated in cost, performance or safety. Additionally, lamination processing of LiBs has enormous built in costs, including up to two months' of careful, pre-processing time for cells before they can be shipped to customers, comprising tremendous work-in-process (WIP) and additional process cost and time. These formation and aging costs, coupled with limitations in construction due to lamination, physical limits of transport and mechanics and limited ability to integrate new materials into the existing manufacturing approach, will severely limit gains in performance and safety in this generation of technology. The incumbent technology further requires massive downstream costs to assure the safety of these liquid-based systems, in the form of safety and containment systems. Examination of a mapping of the available materials against their probable effect on cell properties yields a simple conclusion: the incumbent technology benefits have essentially reached their limit, as established holistically by laboratory developments, optimization simulations, and recent commercially reported properties. Recently, Sakti3 has developed an approach for production of all solid state battery cells that offers all of the benefits of the theoretically highest energy density materials available. These massively replicable, cheap and reliable production methods enable cell manufacturing in a single, unified line and produce product that is ready to ship. The technology has already demonstrated an energy density of over 1100Wh/l in prototypes. The core technologies comprise simulations science enabling optimization of materials compositions and morphology, along with process science that employs tooling that can be readily scaled to a production environment. Integration of new, environmentally benign energy generation technologies will require improved energy storage both for regulation of load, and for storage of solar and wind power. Non emissive automobiles and use of existing electrical power grids to power them, require safe, onboard traction storage systems. And finally, the democratization of information and the use of mobile devices as the primary, and often the only, connectivity to the internet and commerce, requires safe, high energy density storage technology be available to the consumer. We discuss our vision for technology deployment and future product development using solid state processing of energy storage technology and integration into existing and new infrastructures.

Biosketch: Sastry brings over 25 years' technical and leadership experience at the University of Michigan, National Laboratories, and public and private sector corporations, to her role at Sakti3. Sastry has co-authored over 110 scientific publications in the world's top journals, delivered over 100 invited lectures at research, government and private institutions globally. She has co-authored over 30 awarded and filed patents. Her teams' industrial work has ranged from polymer processing (DuPont), to controls, battery design, mechanical design, and statistics. Prior to leading Sakti3, Sastry was the Arthur F. Thurnau Professor of Engineering at UM. Tenured and promoted early, she founded and led two research centers in batteries and bioscience, and a global graduate program in energy systems engineering. Her laboratory originated the technical work that underpins Sakti3 technology, and was continuously funded by the DOE for over 17 years. She also led work sponsored by public and corporate sources (NSF, NIH, Army, ONR, DARPA, General Motors, Ford, LBNL, ORNL). She has received several of the highest technical honors in her field, including the 2011 ASME Frank Kreith Energy Award, 2007 ASME Gustus Larson Award and the NSF's PECASE (1997). Her UM recognitions included the Henry Russell and 1938E awards. She holds Ph.D. and M.S. degrees from Cornell University, and a BS from the University of Delaware, all in Mechanical Engineering.

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