Engineered Electrodes for Safer Rechargeable Batteries

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Abstract:

ViPER (Vilas Pol's Energy Research) laboratory at Purdue University focuses efforts on the development of high capacity electrode materials and their engineering with long cycle life and improved safety. Considering the advantages and limitations of known synthesis techniques, a solvent-less, single step ViP processing technology has been developed to fabricate a variety of unique anode and cathode materials for lithium-ion, Na-ion, K-ion and Li-S batteries. The technique has particular merit for producing carbon cavities and metal-carbon composites from inexpensive starch-based precursors. This presentation will reveal selective results on the novel synthesis of 3-dimensional carbon hotels that accommodate electrochemically active, high capacity Sn, Co or Si based nanoguests. Around 300% expansion and contraction during lithiation and delithiation of Co and Si anodes is effectively accommodated in the rooms of conducting carbon hotels minimizing pulverization effects. With the addition of electrolyte additives in Gen 2 electrolytes, high capacity and longer cycle life from these newly developed 3D electrodes are achieved. These carbon hotel rooms are also used to accommodate in-situ formed nanosulfur guest as a cathode of Li-S batteries in the presence of fluorinated ether-based electrolytes, achieving longer cycle life with higher capacities. ViPER's recent efforts on structural, morphological and electrochemical properties of various electro-chemistries will be demonstrated.

Biography:

Dr. Vilas Pol is an Associate Professor at Purdue University's School of Chemical Engineering, USA. He earned his B. Sc.,M.Sc., and M. Phil. degrees from Pune University, India, and later earned his Ph. D. from Bar-Ilan University of Israel. Before joining Purdue University, he was a materials scientist in the Chemical Sciences and Engineering Department at the Department of Energy's Argonne National Laboratory, IL. Dr. Pol has 17 years of research experience in the fields of energy storage, materials chemistry, engineering and electrochemistry. He developed numerous synthetic approaches for the fabrication of various functional electrode materials, including anodes and cathodes of Li-ion batteries, K-ion, Na-ion and Li-S batteries. Dr. Pol's scientific breakthroughs have been featured in various media outlets including New Scientist, Discovery, Popular Science, Smithsonian, USA Today, Forbes, ACS, MRS, DOE webpages, ABC7 news, Asia TV, Univision, and NOVA's "making stuff cleaner" program. He has authored or co-authored more than 125 research publications (h index36), four book-chapters, and the associated inventor on 15 US patents/applications. Other achievements include an ACS Grand Prize winner, the Argonne National Laboratory's distinguished 'Directors postdoctoral fellowship' awardee, the MRS Science as Art first prize winner, Intel prize, Argonne's Near Hit Safety award, 2013 British Carbon Society's Brian Kelly award, and a 'Gold Medalist' in Sports. In 2015, his sustainable 'Versatile Hard Carbon Microspheres Made from Plastic Waste' technology was selected as one of the 100 most technologically significant new products of the year. In 2016, he received the American Institute of Chemical Engineer's Sustainable Engineering Forum Research Award. Dr. Pol's 'Up Carbon' technology developed at Purdue University was a finalist for the 2016 "R and D 100 award".

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