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Improvement of capacity retention of $LiMn_2O_4$ using various coatings as a cathode material to LIBs

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The market of LIBs develops rapidly. These batteries are commonly used in portable electronic devices, such as: cell phones, notebooks, tablets, ipods, media players, as well as in hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), owing to its high energy density and working voltage, long lifecycle, small dimensions and weight. Especially, the last applications require large format batteries and their safety becomes a key issue.

Lithium manganese oxide ($LiMn_2O_4$) of spinel structure has been extensively studied as a cathode material for Li-ion batteries. Application of $LiMn_2O_4$ has several advantages like: low cost, easy preparation, non-toxicity, high potential (4V vs. Li metal), a satisfactory capacity, high-energy density, low self-discharge and high thermal and structural stability. In spite of these advantages, $LiMn_2O_4$ suffers from a serious capacity fading during charge-discharge cycles, which is unacceptable in commercial applications. This problem can be caused by several factors: manganese dissolution, electrolyte decomposition at high potentials, the Jahn-Teller distortion at the state of a deep discharge and lattice instability.

In order to resolve this complicated problem, in our work, we investigated and compared the electrochemical performance of $LiMn_2O_4$ coated by various; metallic (i.e. Ag), carbon (i.e. grapheme oxide) and ceramic oxides (i.e. SiO_2). The wet chemical method was used to modify the surface grains of LMO. The crystal structures of samples were characterized by XRD and Raman spectroscopy. The particle size and morphology were observed by: SEM, TEM. Also, the electrochemical tests were performed. The results of these measurements will be presented at the conference.

Biography

Monika Michalska is a Vice President of NANONET Foundation, non-profit organization. She is also Editor-in-Chief on NANONET Newsletter. She is a Research Assistant at the Institute of Electronic Materials Technology. She specializes in the field of materials science/chemistry/nanotechnology, including in particular the preparation of electrode (for cathode and anode) nanomaterials for lithium ion batteries and supercapacitors using various chemical methods. She also synthesizes composites with ceramic oxide or metallic materials and with carbon coatings: with graphene flakes, graphene oxide and reduced graphene oxide (which are produced in our laboratory).

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Graphene based anodes for next generation Li-ion batteries

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Conventional graphitic anodes in lithium-ion batteries cannot provide high power densities due to slow diffusivity of lithium ions in the bulk electrode material. In the talk it will be described the novel photo-flash and laser reduced free-standing graphene paper as high-rate capable anodes for lithium-ion batteries. Photo-thermal reduction of graphene oxide yields an expanded structure with micron-scale pores, cracks and inter-sheet voids. This open pore structure enables access to the underlying sheets of graphene for lithium ions and facilitates efficient intercalation kinetics even at ultra-fast charge/discharge rates of >100C (i.e. 2 orders of magnitude faster that conventional graphitic anodes). At low charge/discharge rates the photo-thermally reduced graphene anode also shows an energy density that is 2-3 fold higher than conventional graphitic anodes. Importantly photo-thermally reduced graphene anodes are structurally robust and display outstanding stability and cycling ability. At charge/discharge rates of ~40 C, photo-reduced graphene anodes delivered a steady capacity of ~156 mAh/g anode continuously over 1,000 charge/discharge cycles, providing a stable power density of ~10 kW/kg anodes. Such electrodes are envisioned to be mass scalable with relatively simple and low-cost fabrication procedures, thereby providing a clear pathway towards commercialization.

Biography

Nikhil A. Koratkar is the John A. Clark and Edward T. Crossan Professor of Engineering at the Rensselaer Polytechnic Institute. His research has focused on the synthesis, characterization, and application of nanoscale material systems. This includes graphene, graphene oxide, carbon nanotubes, fullerenes, as well as metal and silicon nanostructures produced by a variety of techniques such as exfoliation of graphite, chemical vapor deposition, and oblique angle sputter and e-beam deposition. He is the co-author of over 100 journal papers and is presently serving as an editor of the Elsevier journal CARBON.

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