Supporting Information for Manuscript Entitled

Utilizing an ionic liquid for synthesizing a soft matter polymer "gel" electrolyte for high rate capability lithium-ion batteries

Monalisa Patel, M. Gnanavel and Aninda J. Bhattacharyya
Solid State and Structural Chemistry Unit,
Indian Institute of science, Bangalore 560012, India

Supporting information 1

Synthesis of C/MWCNT-$LiFePO_4$ electrode materials: Lithium iron phosphate coated with amorphous carbon (C-LFP) and with MWCNT (MWCNT-LFP) were synthesized essentially using a sol-gel method [1, 2]. For synthesis of MWCNT-LFP, 0.03 mol ferric citrate ($C_6H_5FeO_7$, Sigma-Aldrich) was dissolved in water and then heated at 60 ^{0}C for 1 h (A). In another beaker an aqueous mixture of 0.02 mol phosphoric acid (H_3PO_4, Fisher Scientific) and 0.01 mol lithium phosphate (Li_3PO_4, Sigma-Aldrich) were heated at 70 ^{0}C for 1 h. This results in the formation of LiH_2PO_4 in the aqueous solution (B). Mixtures (A) and (B) were mixed together at approximately 60 ^{0}C. To the resulting transparent sol, 0.5 % MWCNTs (diameter: (10-30) nm; purity > 90 %, M/s Sun Nanotech) of the total precursor weight (i.e. ferric citrate, lithium phosphate and phosphoric acid) were dispersed and the sol-MWCNT mixture was homogenized using a sonicator (approximately 2 min). The homogeneous mixture was again reheated at 60 ^{0}C for nearly 24 h. The green color product was ground thoroughly with an agate pestle and mortar and annealed under argon atmosphere at 700 ^{0}C for 10 h (heating rate of 3^{0}C min^{-1}). For the synthesis of C-LFP exactly same procedure was followed but without the addition of MWCNTs.

Electrode preparation and electrochemical characterization: Room temperature (= 25 ^{0}C) galvanostatic charge and discharge cycling were carried out in Swagelok ^{TM} cells

with C/MWCNT-LFP and metallic Li (Aldrich) as cathode and anode, respectively. Whatman glass fiber separator soaked with 0.5 M LiTFSI-[$Py_{1,4}$-TFSI] was used in between the electrodes. For polymer gel electrolytes no separator materials were used for sandwiching the electrolyte between the electrodes. The cells were assembled inside an argon-filled glove-box (MBraun, H_2O: < 0.1 ppm) and the voltage range for galvanostatic cycling was 2.0-3.8 V. The composite C/MWCNT-LFP electrode was prepared by mixing C-LFP or (0.5%)MWCNT-LFP, carbon black (Alfa Aesar) and poly (vinyl difluoride) (PVDF, Kynarflex) in the ratio of 85:8:7 (by w/w) in *N*-methyl-pyrrolidone (NMP). The slurry was cast on Al foil (Alfa Aesar, thickness= 0.1 mm) and dried in a vacuum oven at 120 ^{0}C overnight.

References

1. R. Dominko, M. Bele, M. Gaberscek, M. Remskar, D. Hanzel, J. M. Gupil, S. Pejovnik, J. Jamnik, *J. Power. Sources*, **153**, 274 (2006).
2. M. Gaberscek, R. Dominko, M. Bele, M. Remskar, D. Hanzel, J. Jamnik, *Solid State Ionics.*, **176**, 1801 (2005).