$LiNi_{0.5}Mn_{1.5}O_4$ Nanowires Produced by Electrospinning Method

Rui Xu[1,2], Ilias Belharouak[2], Jianglan Shui[2], James C.M. Li[1]
[1]Materials Science Program, University of Rochester, Rochester, NY 14627
[2]Chemical Science and Engineering Division, Argonne National Laboratory, 9700 South Cass Ave., Argonne, IL 60439

High voltage spinel nanofibers with a chemical composition of $LiNi_{0.5}Mn_{1.5}O_4$ were synthesized using the electrospinning method followed by a heat treatment. The as-prepared fibers were 50 nm in diameter. Polyacrylonitrile (PAN) and polyvinylpyrrolidone (PVP) were used as the electrospinning media. Li-Ni-Mn-O containing precursor materials and polymer were dissolved in a solvent separately and they were mixed before electrospinning. Precursor/polymer fibers were heat treated, during which the precursor transformed to energy-storage $LiNi_{0.5}Mn_{1.5}O_4$ nanowires and polymers were burned over. The surface morphology and microstructure of the obtained composite $LiNi_{0.5}Mn_{1.5}O_4$ nanowires were characterized using scanning electron microscopy (SEM). XRD measurements were also carried out in order to determine the structure of the as-prepared material.

The setup for electrospinning is shown in Figure 1. It consisted of a high voltage supplier (Matsusada Precision, China), a syringe pump (Harvard Pump11, U.S.A.), and a plastic syringe equipped with a 22 gauge stainless steel needle. Carbon paper was used to collect the composite fiber. The polymer used included PVP of 1.3×10^6 MW or PAN (Polyacrylonitrile) obtained from Aldrich. The salts used that contain Li, Mn and Ni elements were $LiC_2H_3O_2\cdot2H_2O$, $Ni(C_2H_3O_2)_2\cdot4H_2O$ and $Mn(C_2H_3O_2)_2\cdot4H_2O$ from VWR. Solvent used was methanol or DMF (Dimethylformamide). The distance between the tip of the syringe and the carbon paper collector was 5-15 cm and the applied electric field was 0.8-2 kV/cm. Solution feeding speed was 0.1~0.3 mL/h. Temperature was around 25C in room environment. To obtain the final product of $LiNi_{0.5}Mn_{1.5}O_4$ nanowires, the precursor fibers underwent a heat treatment under different temperatures for the salts to react in air atmosphere.

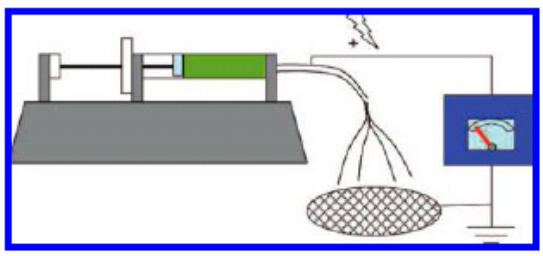

Fig. 1. The setup of electrospinning [1]

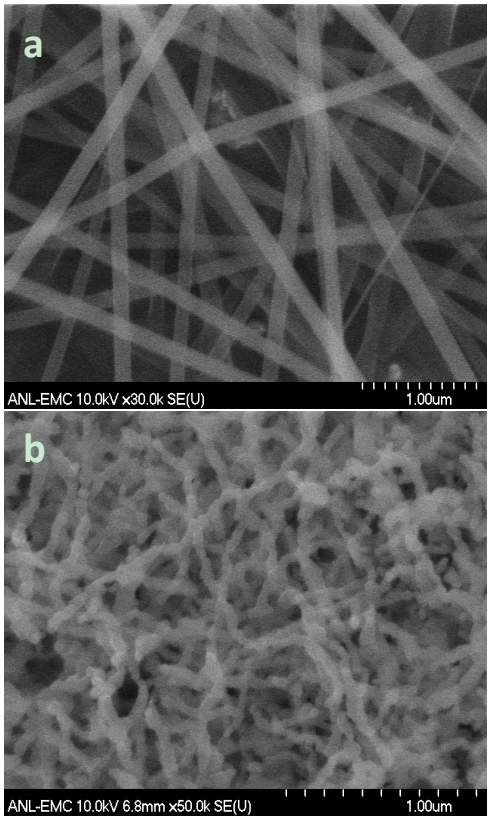

Figure 2: Scanning electron micrographs of PVP/acetates electrospun fibers before (a) and after (b) heat treatment ($LiNi_{0.5}Mn_{1.5}O_4$ fibers).

REFERENCES

1. J.L. Shui, J. C.M. Li, Nano Lett. 9(4) (2009)1307-1314.
2. F. Yi, D. A. LaVan, Macromol. Biosci. 8 (2008) 803–806.
3. Y.Z. Zhang, X. Wang, Y. Feng, J. Li, C. T. Lim, and S. Ramakrishna, Biomacromolecules 7 (2006) 1049-1057.
4. Y. Lu, H.L. Jiang, K.H. Tu, L.Q. Wang, Acta Biomaterialia 5 (2009) 1562–1574.
5. X. Zong, K. Kim, D. Fang, S. Ran, et al. Structure and Process Relationship of Electrospun Bioabsorbable Nanofiber Memberanes. Polymer 2002, 43, 4403–4412.