Electronic supplementary information:

Temperature-Sensitive Cathode Materials for Safer Lithium–ion Batteries

Lan Xia, Su-Li Li, Xin-Ping Ai *, Han-Xi Yang, Yu-Liang Cao

CONTENTS

Experimental details:

Materials synthesis: P3DT used in this study was synthesized by chemically oxidative polymerization of 3-decylthiophene monomer in chloroform using $FeCl_3$ as a catalyst. The as-prepared P3DT was washed with methanol and then added into a mixture of chloroform and monohydrate hydrazine for de-doping under magnetic stirring. Finally, the de-doped polymer was extracted with methanol in a Soxhlet extractor for removing the residual oxidant and oligomers.

P3DT-$LiCoO_2$ composite in this study was designed to contain 10 wt % P3DT and prepared via a spray drying method. A typical procedure is to add commercial $LiCoO_2$ powder (Fenghua Lithium battery Co., Ltd. Zhaoqing, China) into a P3DT-CH_2Cl_2 solution in a weight ratio of P3DT:$LiCoO_2$ = 1:9 at mild stirring to form the well-dispersed suspension and then spray-dry the suspension into powdered particles using SD-1500 Laboratory Scale Spray Drier (TriDwin Tech. Co., Shanghai, China).

Materials characterization: The surface morphology of the P3DT-$LiCoO_2$ particles was characterized by transmission electron microscopy (TEM, JEOL-2010). The resistance of the composite cathode were measured directly by a digital multi-meter using a thin cathode film sandwiched between two parallel Ni plates at temperature of 20 to 130℃.The positive electrodes were prepared by mixing 90wt.% $LiCoO_2$ @P3DT powder or $LiCoO_2$ powder, 3wt.% acetylene black and 7wt.% PTFE(poly tetrafluoroethylene) into a paste and roll-pressing the mixed paste into about 200 μm thick film, finally, pressing the electrode film into an aluminum grid.

All the electrochemical characterization for pure $LiCoO_2$ cathode and P3DT-$LiCoO_2$ cathode were carried out using coin cells with lithium sheet as counter electrode. The electrolyte solution was 1M $LiPF_6$ in ethylene carbonate (EC)-dimethyl carbonate (DMC) (1:1 by vol.), purchased from Guotai-Huarong New Chemical Materials Co., Ltd. (Zhangjiagang, China). The cells were assembled in an argon-filled glove box. The charge and discharge measurements were performed using a programmable computer-controlled battery charger (CT2001A Land Battery Testing System, Wuhan, China) at a voltage interval of 4.30~3.0 V. Cyclic voltammetry measurements were conducted on a CHI660 electrochemical workstation (Chenhua Instrument Co. ,Shanghai, China) at a scan rate of 0.1 mV s^{-1}.

Temperature dependence of the DC conductivity for doped polythiophene (PTH), poly (3-butylthiophene) (P3BT) and poly (3-decaylthiophene) (P3DT) .

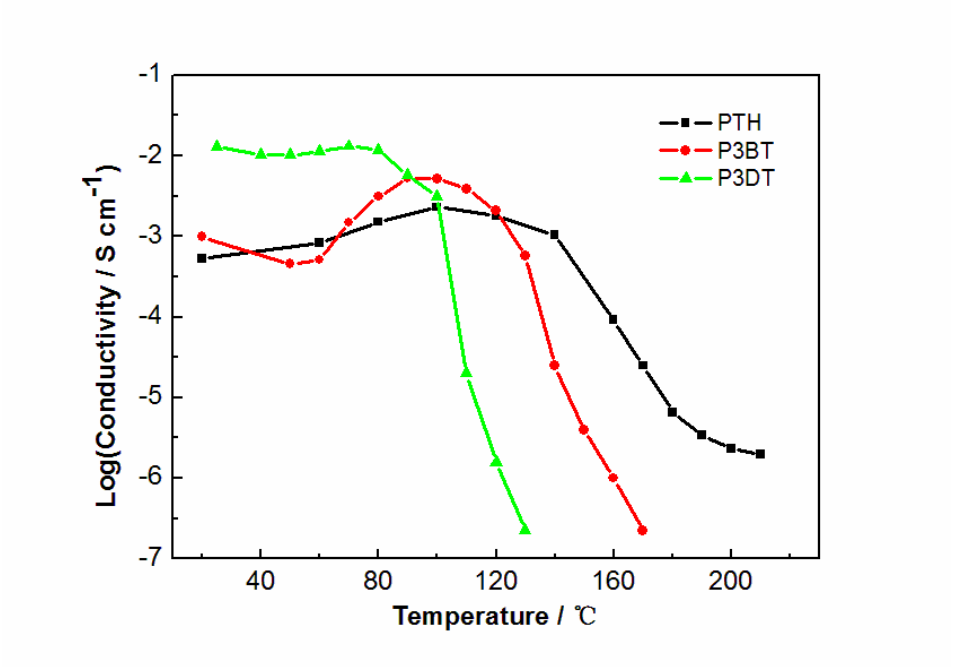

Figure S1. Logarithmic conductivity of doped polythiophene (PTH), poly (3-butylthiophene) (P3BT) and poly (3-decaylthiophene) (P3DT) at various temperature

The charge and discharge curves of uncoated $LiCoO_2$ electrode at constant rate of 40 mA g^{-1}.

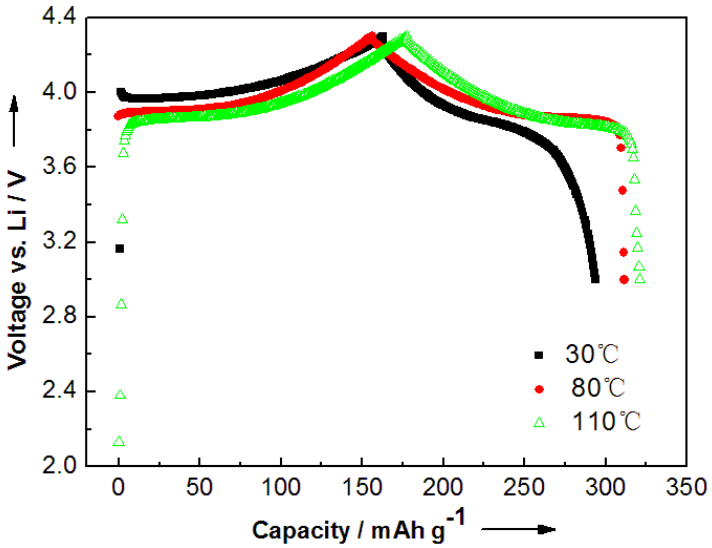

Figure S2. The charge and discharge curves of uncoated $LiCoO_2$ electrode at constant rate of 40 mA g^{-1}.

Nyquist impedance spectra of the P3DT@$LiCoO_2$ composite electrode at different temperatures

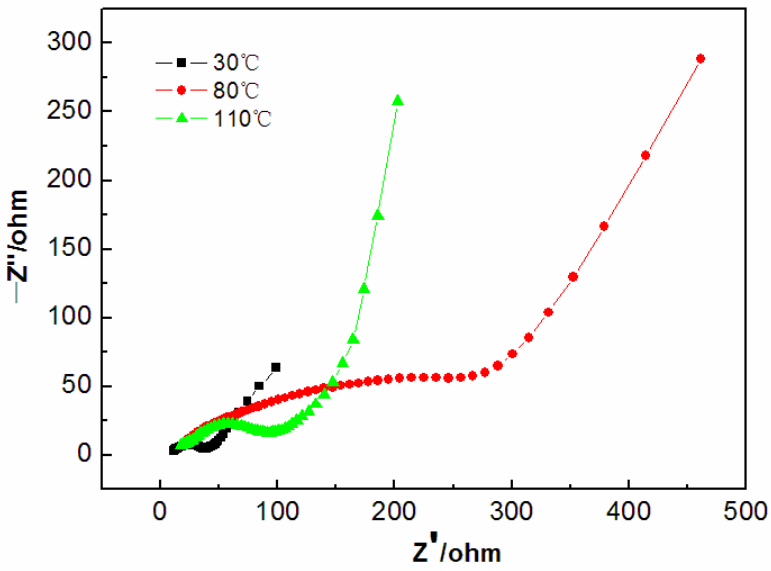

Figure S3. Nyquist impedance spectra of the P3DT@$LiCoO_2$ composite electrode at different temperatures.