Electronic Supplementary Information (ESI)

An All-organic Rechargeable Battery Using Bipolar polyparaphenylene as Redox-active Cathode and Anode

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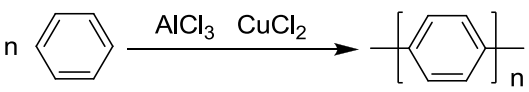
1. Experimental details

Materials preparation. Poly (p-phenylene) (PPP) was prepared using aluminium chloride - cupric chloride as catalyst according to Kovacic's method.[1] The synthetic route was showed in Scheme 1. Firstly, benzene (0.78g, 10 mmol) was added dropwise into anhydrous $AlCl_3$ (0.334g, 2.5 mmol) and $CuCl_2$ (0.336g, 2.5 mmol) at 0 °C and the reaction mixture were stirred for 1 hour. This solution was then stirred for 2 hours at room temperature. The resulting mixture was filtered and subsequently the polymeric precipitate was washed several times with hot 18% hydrochloric acid solution and finally dried at 60 °C under vacuum for 24 h to give brown powder. The as-prepared PPP was further heat-treated in a muffle furnace for 36 h at 400 °C.

All chemicals were purchased from commercial sources and used without further purification unless except otherwise noted.



Scheme 1. Synthetic route of PPP

Structural and electrochemical characterizations. The crystalline structure of the PPP polymer was characterized by powder X-ray diffractometry (XRD) on a Shimadzu XRD-6000 diffractometer with CuKa source. The FT-IR spectra of PPP were recorded on a NICOLET AVATAR360 FT-IR spectrometer with KBr pellets. The particle morphology of PPP powder was examined by scanning electron microscopy (SEM) on a Sirion 2000 machine (Holland).

Cyclic voltammeter (CV) was performed with a powder microelectrode using a two-electrode cell, a larger lithium sheet served as both counter electrode and reference electrode. The CVs were recorded using a CHI 660C electrochemical workstation (Shanghai, China). The charge - discharge measurements were carried out using 2016 type coin cells. The cells were assembled in an argon-filled glove box, using a Li metal disc as the negative electrode and a Whatman GF/D borosilicate glass fiber sheet saturated with 1mol L^{-1} $LiPF_6$ in ethylene Carbonate (EC), dimethyl carbonate (DMC) and ethyl methyl carbonate (EMC) (1:1:1 w/w/w) as the electrolyte. The PPP electrode film was consisted of 70% PPP powder, 20% acetylene black, 10% PTFE (wt.%) and prepared by roll-pressing the mixture into an thick film and then pressing the film onto an collector. The charge - discharge experiments were executed using a programmable computer-controlled battery charger (LAND CT2001A, Wuhan, China).

2. The XRD spectra of the PPP samples

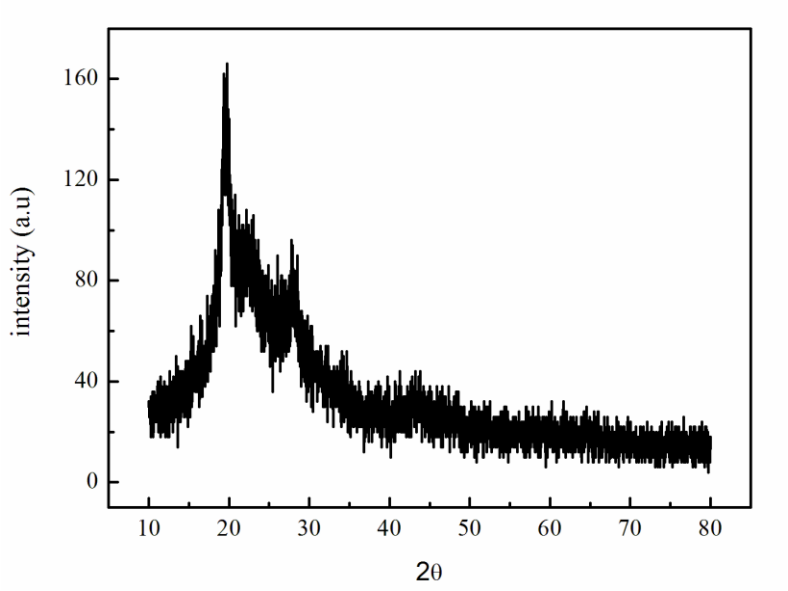


Figure S1. The XRD spectra of the PPP samples

3. Cycling capacities of coin-type Li- PPP cells at various charge-discharge rates

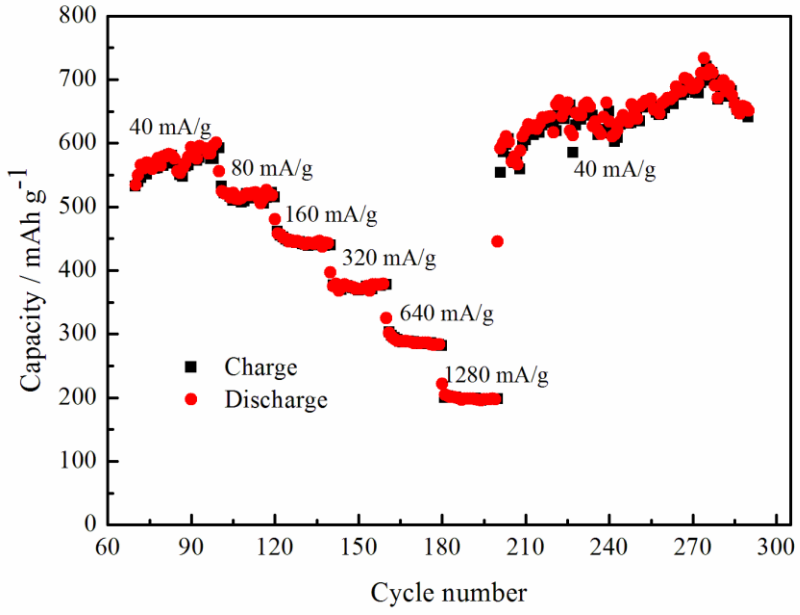


Figure S2. Cycling capacities of coin-type Li- PPP cells at various charge-discharge rates as labeled in the figure.