Electronic Supplementary Information:

Enhanced Electrochemical Performance of MWNT@MnO_2 Composites in Polymerized Ionic Liquids

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Experimental section

Synthesis of samples

The multi-walled carbon nanotubes (MWNT) with diameter of 20-60 nm purchased from Shenzhen nanoport company, and it was treated with concentrated HNO_3 (16 mol/L) in 140 for 14 h. The pure MnO_2 was synthesized using potassium permanganate ($KMnO_4$) and manganous sulfate ($MnSO_4$) as the starting materials. The MWNT was dispersed into $KMnO_4$ solution by untrosonicating to synthesize MWNT@MnO_2 composites. The dispersed mixture was stirring for 24 h at 70 ℃, following with filtering and washing. MWNT@MnO_2, 1-vinyl-3-ethyl imidazole salt bromine ([VEIm]Br), azodiisobutyronitrile (AIBN) and with mole ratio of 5:1:2 were mixed and grinded for 10 min. The mixture reacted for 6 h at 60 ℃ in N_2 airflow. The non-reactive monomers and initiators were removed by washing and filtering. The sample was signed for MWNT@MnO_2@PIL.

Characterization

The thermogravimetric analysis (TGA) was carried out on NETZSCH STA-449C in a range from 30-1000 ℃ with a heating rate of 10 ℃/min in air flow. Infrared spectroscopy was performed in a Tensor 27 FT-IR spectrometer. X-ray diffraction pattern(XRD) were recorded on a Miniflex Ⅱ diffractometer equipped with Cu/Kα radiation(λ = 0.15405 nm) (30 kV, 15 mA). The size was calculated according to the Debye–Scherrer equation of $D=K*\lambda/(\beta*\cos\theta)$. Transmission electron microscopy (TEM) images, high-resolution transmission electron microscopy (HRTEM) images, selected-area electron diffraction (SAED), as well as energy-dispersive X-ray spectroscopy (EDS) were performed on a JEOL JEM-2010 with an acceleration voltage of 200 kV.

The Cyclic voltammetry and galvanostatic charge/discharge studies were performed using an electrochemical workstation (CHI 660d) with a conventional three-electrode electrochemical cell. The electrodes were prepared by casting the slurry mixtures of 90 wt.% samples and 10 wt.% polyvinylidene difluoride (PVDF) onto a nickel foam current collector. The electrolyte was 1 M Na_2SO_4 aqueous solution. The as-prepared samples were used as working electrodes, a platinum wire and saturated calomel electrode (SCE) were used as counter and reference electrodes, respectively. Cyclic voltammetry was measured in the potential range between 0 and 1 V *versus* SCE at room temperature at various scan rates from 5 to 200 mV/s. Galvanostatic charge-discharge measurements were carried out between 0 to 1 V at different current density from 1 to 20 A/g.

Supplementary Figures

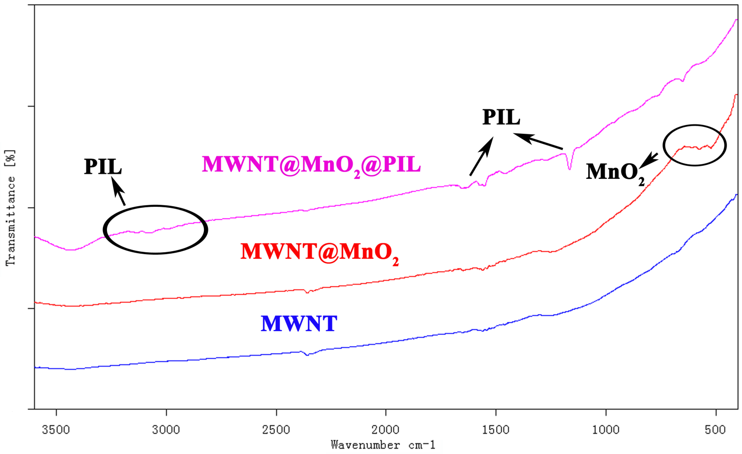

Figure S1. IR spectra of MWNT, MWNT@MnO_2 and MWNT@MnO_2@PIL.

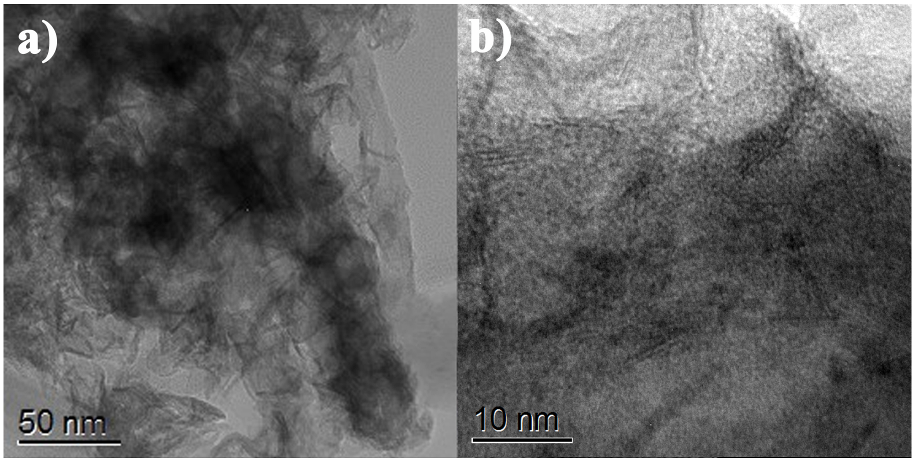

Figure S2. TEM images of TEM images of MWNT@MnO_2@PIL.