

Supporting Information

Preparation of triazine containing porous organic polymer for high performance supercapacitor application

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1. Materials

Melamine (M) , triformylphloroglucinol (TFP), and chemical reagents were purchased from commercial sources and used without further purification.

2. Experimental details

Synthesis of POP_{M-TFP}

M (63 mg, 0.5 mmol) , TFP (105 mg, 0.5 mmol) and dimethyl sulfoxide (DMSO)

(20 mL) were positioned in a beaker and stirred for 10 minutes to get a homogenous solution. Then the mixture transfer to a high pressure reactor at 160 °C. After keeping still for 24 hours, the deep yellow solid was isolated by centrifugation, washed with DMSO (3 × 5 mL) , deionized water (3 × 5 mL), and ethyl alcohol (3 × 5 mL). Then the sample was positioned in a vacuum oven equipped with a rotary-vane vacuum pump overnight with a pressure of <133 Pa at 80 °C . The final product POP_{M-TFP} obtained as a deep yellow powder.

3. Instrumentation and characterization

Fourier transform infrared (FT-IR) spectra were recorded with a Nicolet iS5 instrument in the range of 4000 to 400 cm⁻¹ in KBr plate.

X-ray photoelectron spectroscopy (XPS) were performed on Thermo ESCALAB 250XI instrument.

Solid-state NMR experiments were performed on a JNM-ECZ600R 600 MHz spectrometer. The ¹³C cross-polarization (CP) MAS NMR spectra were recorded with a 4-mm double-resonance MAS probe and with a sample spinning rate of 10.0 kHz.

X-ray diffraction (XRD) patterns of the powder material were obtained in a PANalytical X-ray Diffractometer Model X pert3 using Cu-K α radiation.

The N₂ adsorption/desorption isotherms of the materials was measured using a Autosorb-IQ system instrument.

Field emission scanning electron microscopy (SEM) observations were performed on a JSM-6700F microscope operated at an accelerating voltage of 5.0 kV.

Transmission electron microscope (TEM) observations were performed on a JEM-2100 PLUS microscope.

4. Electrochemical measurements

The as-prepared POP_{M-TFP} was used as electrode materials for supercapacitors. The working electrodes were fabricated by mixing the active material POP_{M-TFP}, acetylene black and binder Polyvinylidene Fluoride (PVDF) in N-methyl-2-pyrrolidone (NMP) with a weight ratio of 80:10:10. The formed paste was pressed at 2 MPa to a piece of nickel foam (1.0 cm × 1.0 cm), and dried under vacuum at 80 °C for 12 h. The mass of the active materials in the prepared electrodes is about 2.4 mg. Electrochemical measurements were conducted in a standard three-electrode system at room

temperature in 2 M KOH aqueous solution. A Pt plate and Hg/HgO electrode were used as the counter electrode and reference electrode, respectively. Cyclic voltammetry (CV) was conducted with a CHI604E electrochemical workstation in the potential window of 0 -0.5 V under various voltage scan rates of 5, 10, 20 50 and 100 mV s^{-1} . The electrochemical impedance spectroscopic (EIS) measurements were obtained using three electrodes in the frequency range of 0.1 Hz to 100 mHz. Nyquist plots were collected at room temperature. The galvanostatic charge–discharge (GCD) tests were conducted on a LAND battery system at the current densities of 0.5, 1, 2, 4 and 8 A g^{-1} . The charge/discharge potential-time curve was used to calculate capacitances based on $C = i\Delta t/\Delta V$, where C (F g^{-1}) is specific capacitance, i (A g^{-1}) represents charge/discharge current density, ΔV (V) represents the potential change during charge/discharge, Δt (s) is the total charge/discharge time.

For the asymmetric supercapacitor, two-electrode were prepared using $\text{POP}_{\text{M-TFP}}$ and activated carbon (AC) as positive electrode and negative electrode, respectively. The mass loading of positive and negative electrode is used in the ratio of 1:3, (1.0 mg cm^{-2} , AC, 3.0 mg cm^{-2}). The cell voltage is about 1.5 V at safe condition. The specific capacitance of the asymmetric cell is calculated as $C=4(i\times\Delta t/ m\times\Delta V)$, where i (A) is the current, t (s) is the discharge time, m (g) is the total mass of the two electrodes, and V (V) is the discharge potential range. The energy density is obtained as $E=CV^2/8$, where C is the specific capacitance and V is the maximum testing potential (1.5 V). The power density is calculated as $P=E/\Delta t$, where E is energy density and Δt is the discharge time.

5. Supporting figures

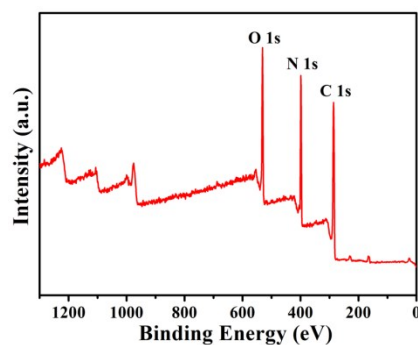


Fig. S1 Full scan XPS spectra of $\text{POP}_{\text{M-TFP}}$.

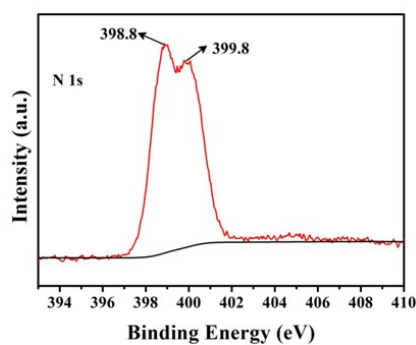


Fig. S2 The XPS spectra of POP_{M-TFP}.

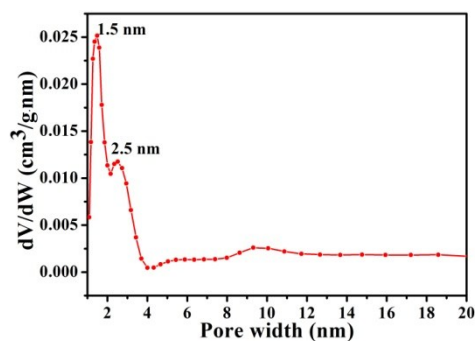


Fig. S3 The pore size distribution plot of POP_{M-TFP}.

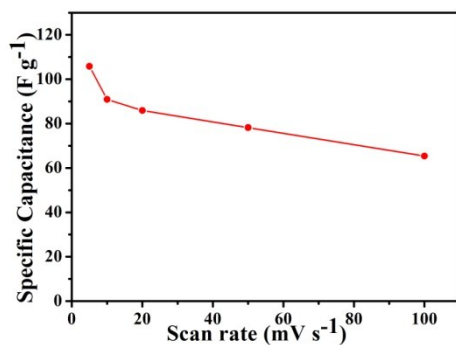


Fig. S4 Specific capacitance *versus* scan rate.

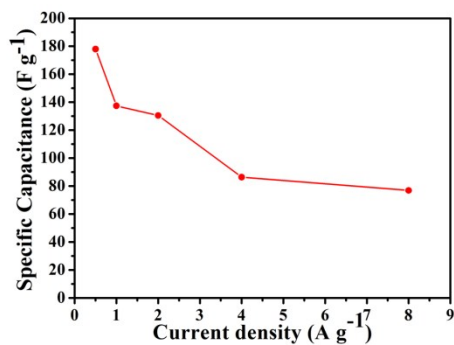


Fig. S5 Specific capacitance *versus* current density.

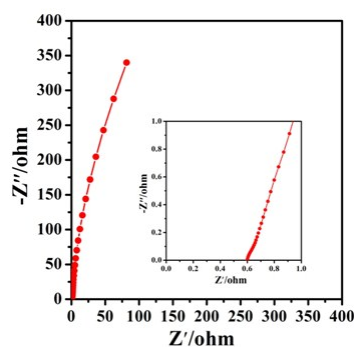


Fig. S6 Nyquist plot of POP_{M-TFP} in the frequency range of 0.1 Hz to 100 mHz. The inset shows the expanded high frequency region.

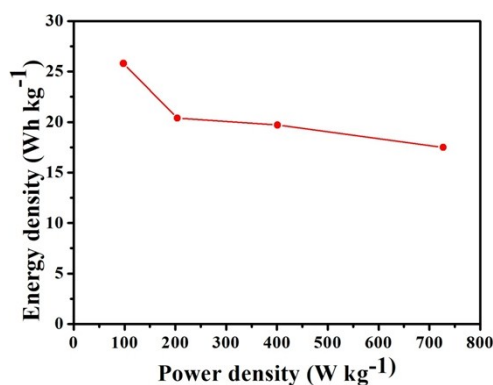


Fig. S7 Ragone plot of energy density *versus* power density for the asymmetric cell.

6. Determination of trizine accessed

(1) Find the mass of the trizine in POP_{M-TFP} on electrode.

POP_{M-TFP} mass=2.4 mg

Trizine comprises 45% of this mass

$2.4 \text{ mg} \times 0.45 = 1.08 \text{ mg}$ of trizine on surface

(2) Convert this mass to moles

$1.08 \times 10^{-3} \text{ g} (\text{mole}/78\text{g}) = 13.8 \times 10^{-6} \text{ mol}$ trizine on surface

(3) Each trizine is a 2 electron process; determine the number of moles of electrons

$13.8 \times 10^{-6} \text{ mol trizine} (2 \text{ mole } e^-/\text{mol trizine}) = 27.6 \times 10^{-6} \text{ mol } e^-$

(4) Determine the maximum coulombs of charge possible to pass

$27.6 \times 10^{-6} \text{ mol } e^- (96485\text{C}/\text{mol } e^-) = 2663 \text{ mC}$

(5) Integrate the oxidation (or reduction) wave

Example: At 1 mV s^{-1} 0.529 mC of charge is passed

(6) Divide the integrated charge by the theoretical and multiply by 100

$0.529 \text{ mC}/2663 \text{ mC} (100) = 1.99\%$