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Disodium Salt of 2,5-dihydroxy-1,4-benzoquinone as Anode Material for Rechargeable Sodium Ion Batteries

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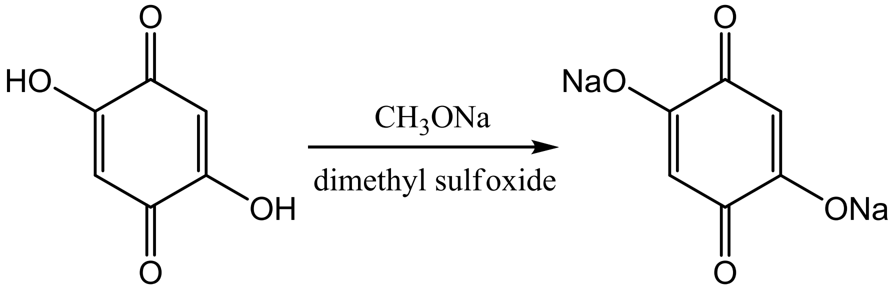
General synthetic route of disodium salt of 2,5-dihydroxy-1,4-benzoquinone



Disodium salt of 2,5-dihydroxy-1,4-benzoquinone (Na_2DBQ) was synthesized through a simple one-pot solution method. Typically, 1 mmol 2,5-dihydroxy-1,4-benzoquinone (H_2DBQ) was first dissolved in 20 ml of dimethyl sulphoxide (DMSO) solution. Then, 2 mmol sodium methylate was added into the mixture. After stirring for 48 h, the precipitate was filtered, washed with DMSO, and vacuum dried at 140 ^oC for 10 h to afford the dull red Na_2DBQ. Yield: 96.6%. ^1H NMR (D2O-d2) 4.65 (2H, s, 3-6-H). Elem. Anal.: C,39.15; H,1.10 Found: C,40.03; H,0.86.

Material characterization

The morphology of prepared Na_2DBQ sample was characterized using field-emission scanning electron microscopy (SEM, FEI NanoSEM-430, 10 kV). FTIR spectra were collected by KBr pellets on a FTIR-650 spectrometer (Tianjin Gangdong) in wavelength range of 400–4000 cm^{-1}. Thermalgravimetric (TG) analysis was carried out on a TG-DSC analyzer (NETZSCH, STA 449 F3) from room temperature to 750 °C at a heating rate of 5 °C min^{-1} under Ar atmosphere.

Electrochemical Measurements.

Electrochemical perfromance was evaluated with CR2032 coin-type cells assembled in an argon-filled glove box (Mikrouna Universal 2440/750). The working electrode was fabricated by casting a mixture of Na_2DBQ (60 wt%), conductive carbon (30 wt%), and PVdF binder (10 wt%) on copper sheets and vacuum dried at 110 °C for 12 h. 1 M $NaClO_4$ in a mixed solvent of ethylene carbonate (EC) and dimethyl carbonate (DMC) (1:1 in volume) was used as electrolyte. Glass fiber was used as separator. The charge-discharge experiments were carried out on a LAND battery testing system in the voltage window of 0.5-2.5 V at room temperature.

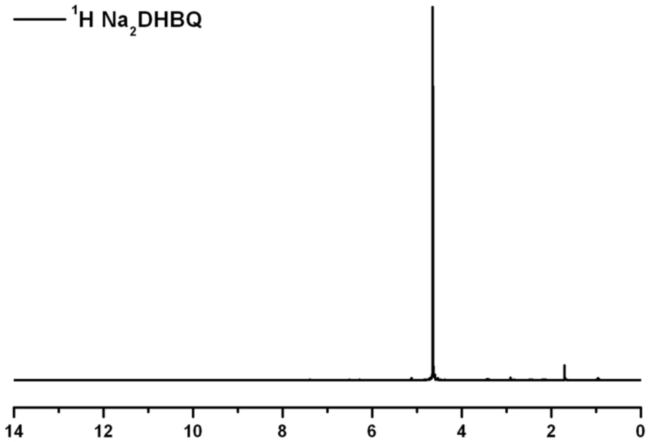


Fig. S1 ^1H NMR spectrum of the as-prepared Na_2DBQ.

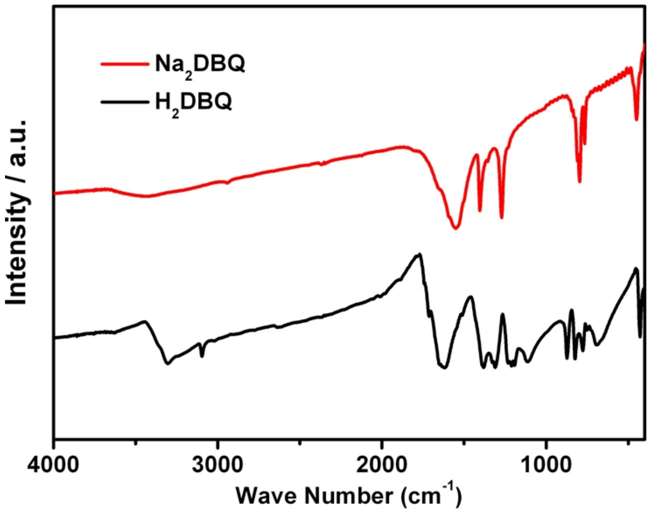


Fig. S2 FTIR specta of the H_2DBQ presursor and obtained Na_2DBQ. After the formation of Na_2DBQ, the peak orignated from the O-H stretching (3305 cm^{-1}) disappeared. Meanwhile, the strething vibration of C=O bond shifts from 1616 cm^{-1} to 1550 cm^{-1}. The change trends derived from the salt formation are in good agreement of previous reported results.[1]

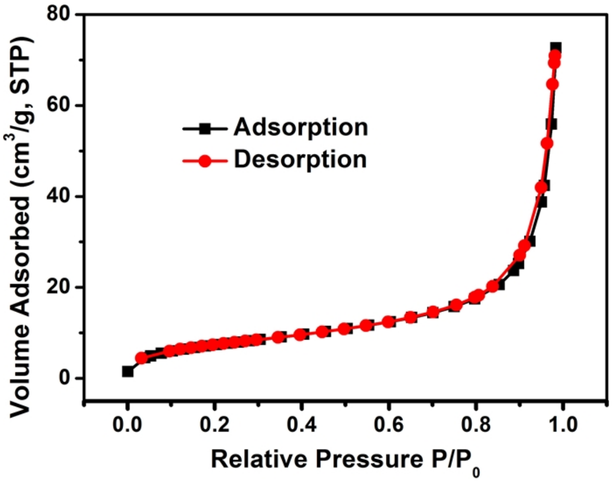


Fig. 3 Nitrogen adsorption and desorption isotherm of Na_2DBQ

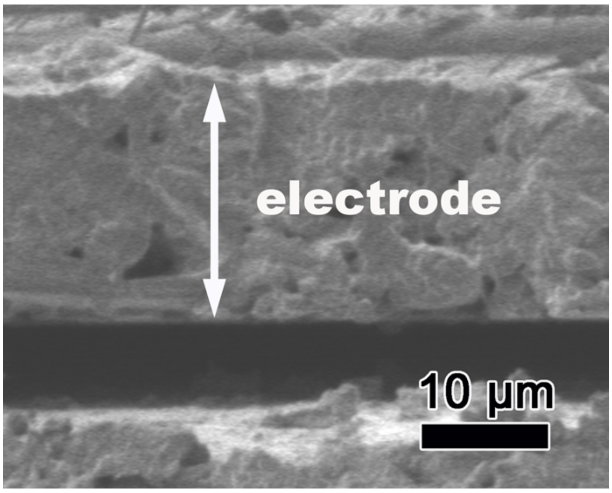


Fig. S4 SEM image of the as-prepared electrode.

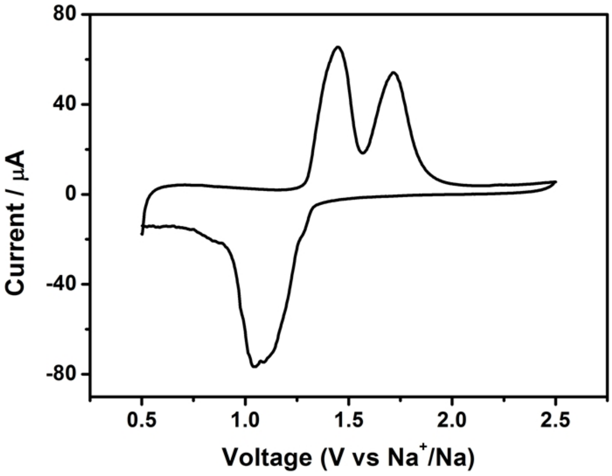


Fig. S5 Cyclic voltammogram curve of Na_2DBQ between 0.5 and 2.5 V at a scan rate of 0.1 mV/s. Tow overlapped peaks centered at 1.04 and 1.10 V are observed during the negative sweep, corresponding to the reduction of carbonyl to form sodium enolate. On the subsequent positive sweep, the peaks originated from the re-oxidation of the enolate groups are also found at 1.44 and 1.71V, indicating good reversibility.

Reference

1 S. Wang, L. Wang, Z. Zhu, Z. Hu, Q. Zhao and J. Chen, *Angew. Chem. Int. Ed.*, 2014, **53**, 5892.