Supplementary Information (SI) for ChemComm.
This journal is © The Royal Society of Chemistry 2024

Electronic Supplementary Information (ESI)

A Nile red dye cathode with an asymmetric redox unit for lithium organic battery

Experimental

Materials: All reagents were obtained from commercial sources and used without further purification. Nile Red (NR) were purchased from heowns and multi-walled carbon nanotubes (MWCNTs) were purchased from Shanghai Macklin Biochemical Co., Ltd. Polyvinylene difluoride (PVDF, Mw ~1,000,000) was purchased from Beijing Huawei Ruike Chemical Co., Ltd. The components of the electrolyte, including bis(trifluoromethylsulfonyl)amine lithium salt (LiTFSI), 1,3-dioxolane (DOL), and 1,2-dimethoxyethane (DME) were purchased from Dodochem.

Characterization: Cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) measurements were performed on an electrochemical workstation (CHI660E). Galvanostatic charge/discharge curves and rate capability tests were carried out on a Land test system (CT3001A, China). X-ray photoelectron spectroscopy (XPS) characterization was conducted on a Thermo Scientific Nexsa equipment. Electron spin resonance (ESR) spectra were recorded on a Bruker EMXplus-6/1 equipment. UV-vis spectra were recorded on a SIMADZU UV-3600i Plus spectrophotometer

Cathode fabrication, coin cell assembly and battery test: The conventional organic electrode is composed of a mixture of 30wt% electroactive materials (NR), 60wt% conductive carbon (MWCNTs), and 10wt% binder (PVDF). A series of electrodes with NR: MWCNTs: PVDF weight ratios as 4:5:1, 5:4:1, 6:3:1, and 0:6:1 were also fabricated and tested. The mixing process was conducted using a conventional mortar and pestle, during which NR, MWCNTs, and PVDF were added to the mortar in sequence and ground for 15 min. The mixture was poured into a tablet mold and punched into circular sheets with 12 mm in diameter. The electrodes were dried at 80 °C in a vacuum oven for over 8 h before assembling coin-type cells in

an argon-filled glovebox. The coin cells were composed of such electrodes as the cathode, lithium metal disc as the anode, glass fiber (GF) as the separator and 1.0 M (1M) or 5.0 M (5M) LiTFSI dissolved in DOL-DME (1:1, v:v) as the electrolyte.

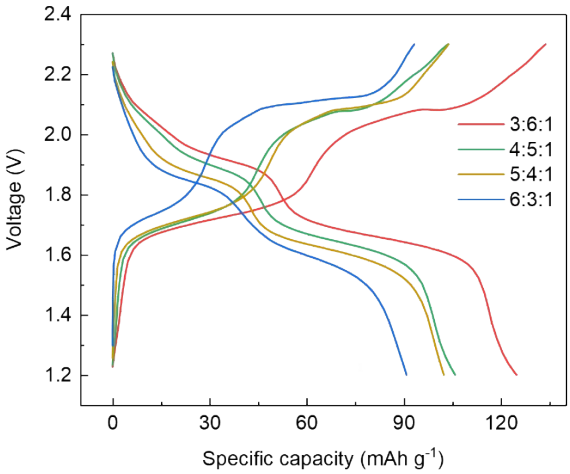

Fig. S1. Discharge/charge profiles of NR-based electrodes with the weight ratios of NR: MWCNTs: PVDF as 3:6:1, 4:5:1, 5:4:1, and 6:3:1, respectively.

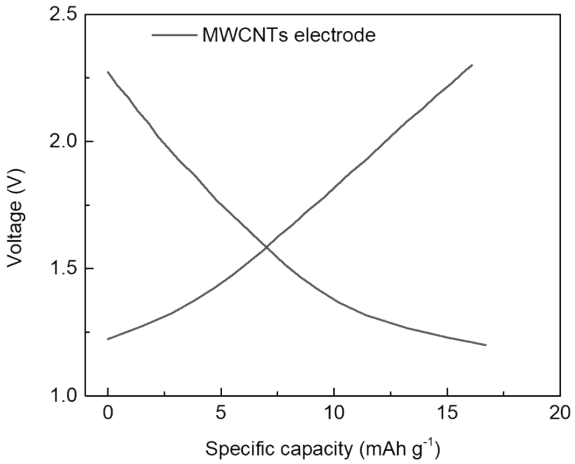

Fig. S2. Discharge/charge profile of MWCNTs electrode. The electrode weight ratio of NR: MWCNTs: PVDF is 0:6:1. For the relevant NR-based electrodes with a 60–30% MWCNTs weight content, the capacities contributions of MWCNTs are calculated only 5–10 mAh g^{-1} out of their capacities of 90–125 mAh g^{-1}.

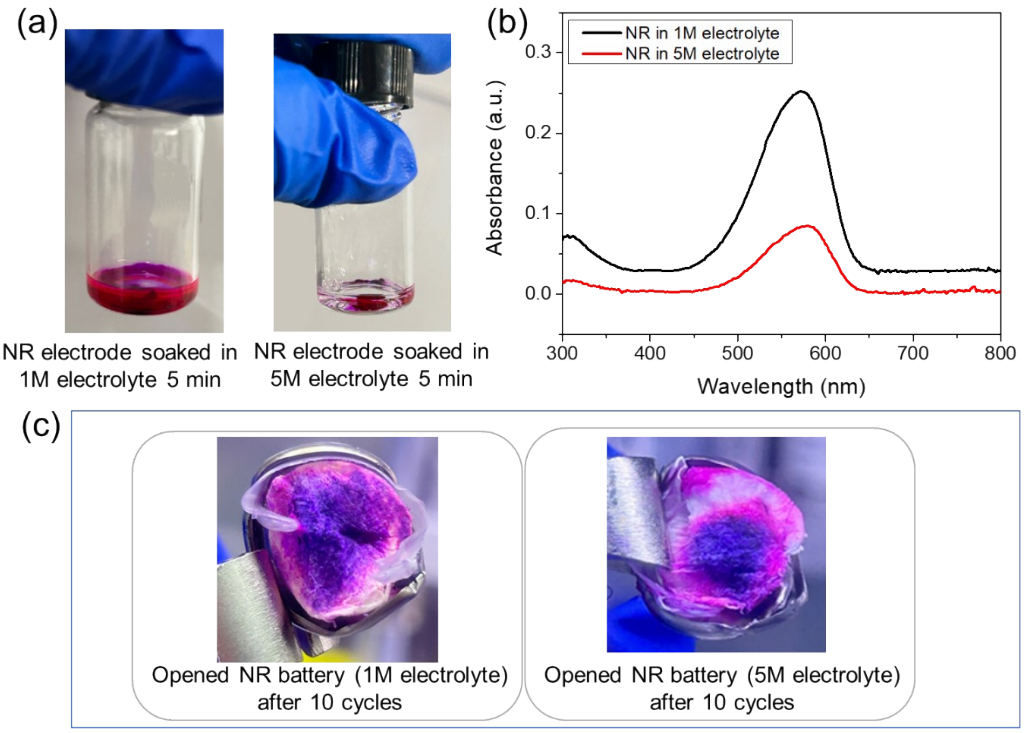

Fig. S3. (a) The images of NR electrode soaked in 1M/5M electrolyte. (b) UV-vis spectra of NR in 1M/5M electrolyte (tested using 1 mg NR soaked in 10 mL 1M/5M electrolyte 10 min). (c) The images of the opened NR batteries (1M and 5M electrolyte) after 10 cycles.

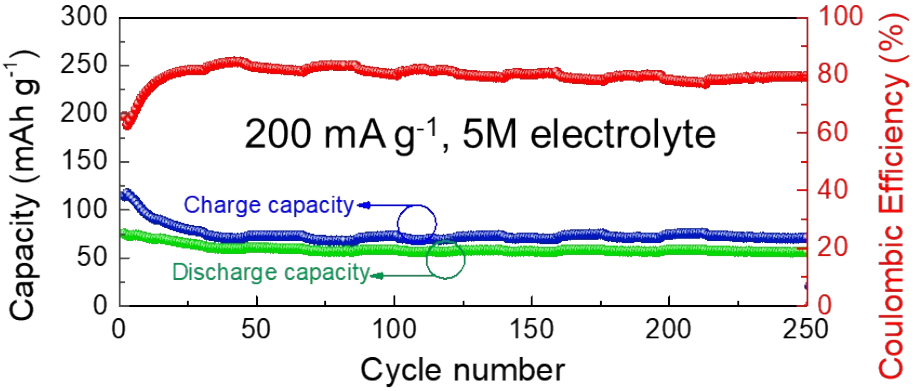

Fig. S4. Cycling performance of NR-based battery using 5M electrolyte at 200 mA g^{-1}.

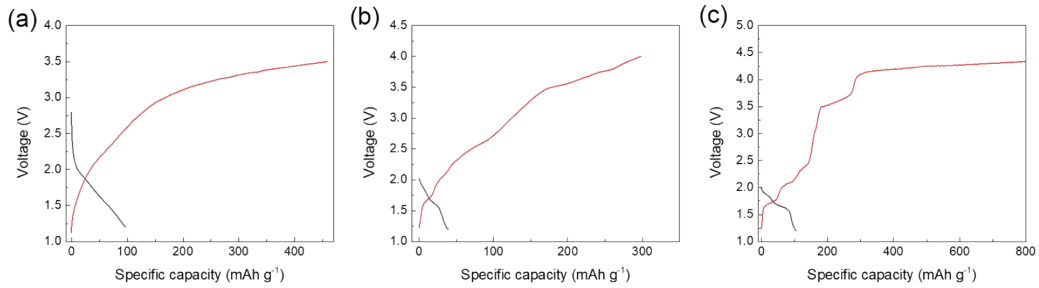

Fig. S5. Discharge/charge profiles of NR-based batteries under the voltage ranges of 1.2–3.5 V (a), 1.2–4.0 V (b), and 1.2–4.5 V (c).

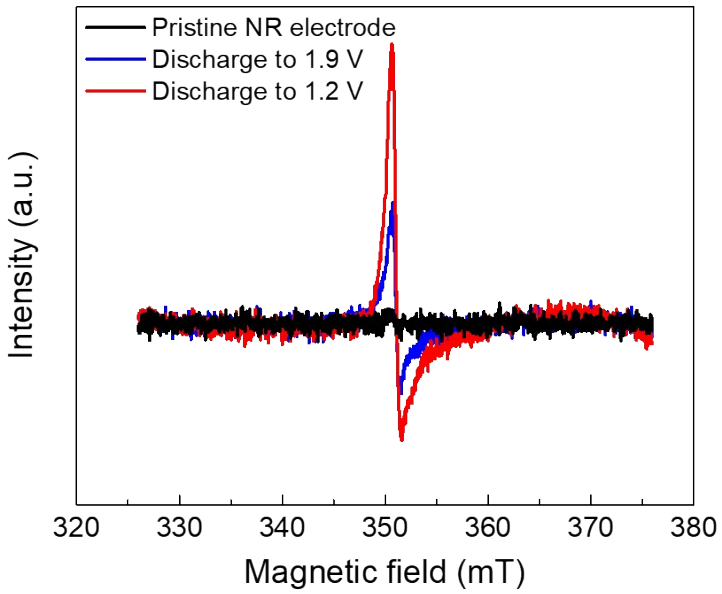

Fig. S6. Electron spin resonance (ESR) spectra of the pristine and two different discharging states NR electrodes.

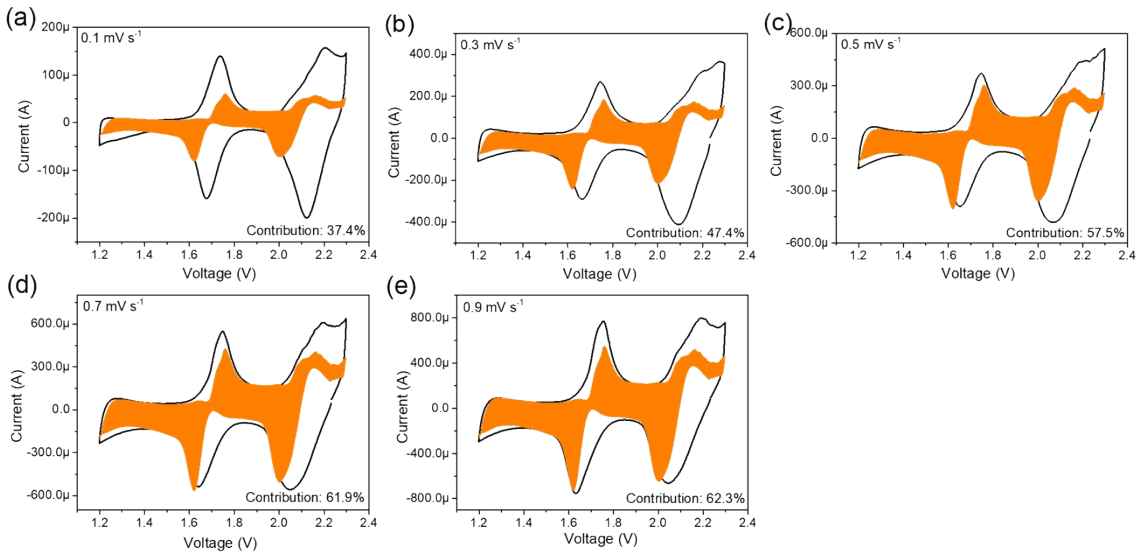

Fig. S7. CV curves and capacitive contributions of NR electrode at scan rates of (a) 0.1, (b) 0.3, (c) 0.5, (d) 0.7, and (e) 0.9 mV s^{-1}.

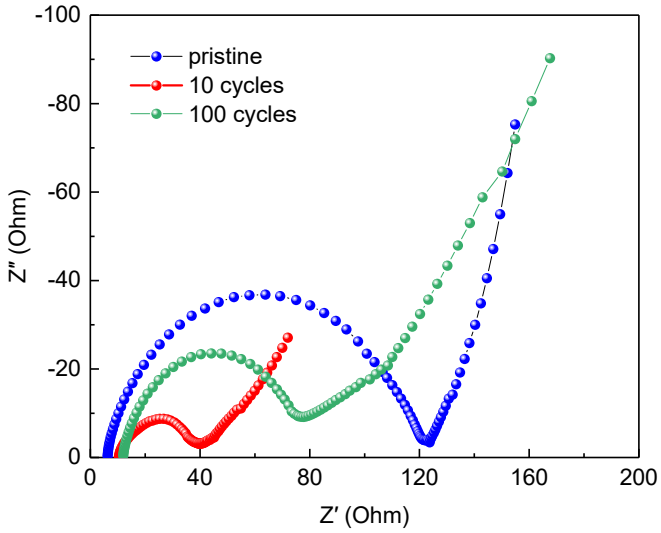

Fig. S8. Nyquist plots of NR electrodes-pristine, NR electrodes after 10 cycles, and NR electrodes after 100 cycles.