Aqueous Organic Flow Batteries toward Sustainable Renewable Energy Storage

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Introduction

Aqueous organic flow batteries (AOFBs) use soluble organics as redox active materials (ORAMs) and stand out for prominent merits. Multiple candidates, including quinones, fluorenones, and viologens, have been developed, yet parasitic side reactions limit practical deployment; electrolyte stability depends on molecular structure and electrolyte environment.

Methods

The naphthalene derivatives and pyrene derivatives were selected as precursors for electrochemical oxidation.

The multi-electron transfer asymmetric pyrene-4,5,9,10-tetraone derivative, and the alkyl-sulfonated high-potential azopyridine derivative are designed for higher energy density.

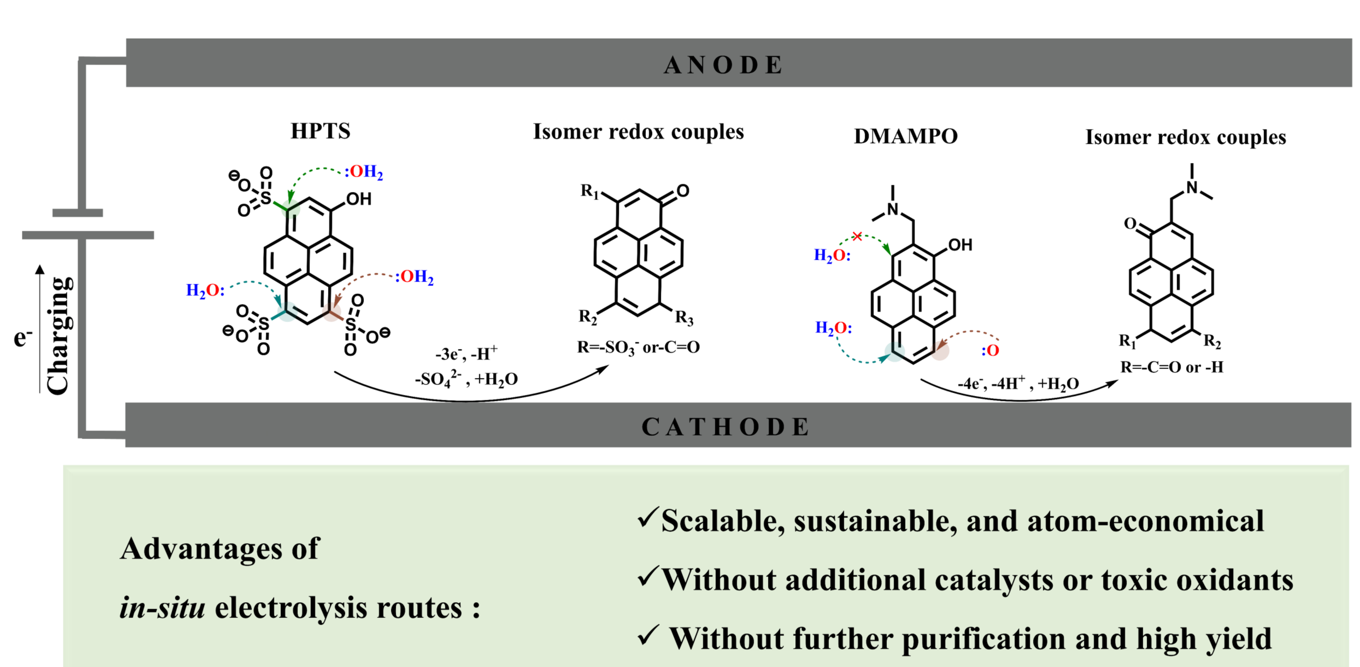

Fig. 1 Chemical and electrochemical reaction of the pyrene derivatives

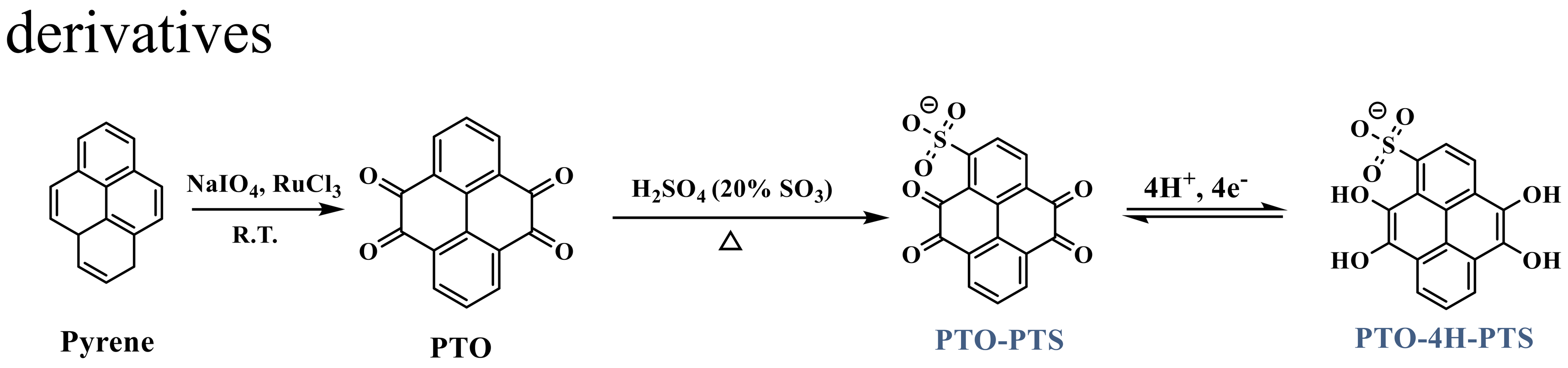

Fig. 2 Synthesis route of pyrene-4,5,9,10-tetraone sulfonate derivatives.

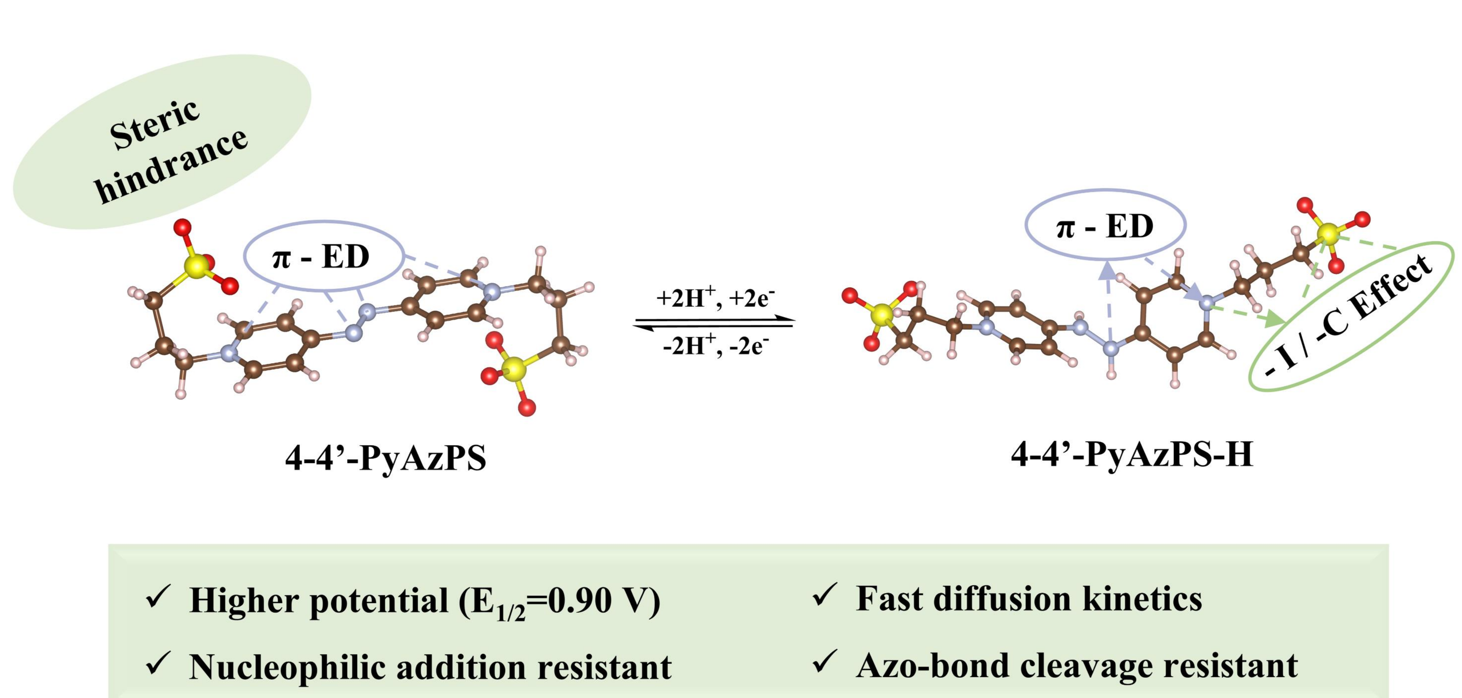

Fig. 3 Functionalized high-potential 4-4′-AZO derivatives.

Results & Conclusions

Herein, we established an in-situ electrochemical synthesis method to produce ORAMs in a flow cell, revealing that the water-attacking pyrenes restructured molecules to produce a variety of isomers and dimers. The alkylamine-stabilized naphthalene derivative demonstrated impressive cell stability under open-air conditions with minimal capacity decay. A 1000 cm^2 kW-scale AOFB stack was established and exhibited stable capacity.

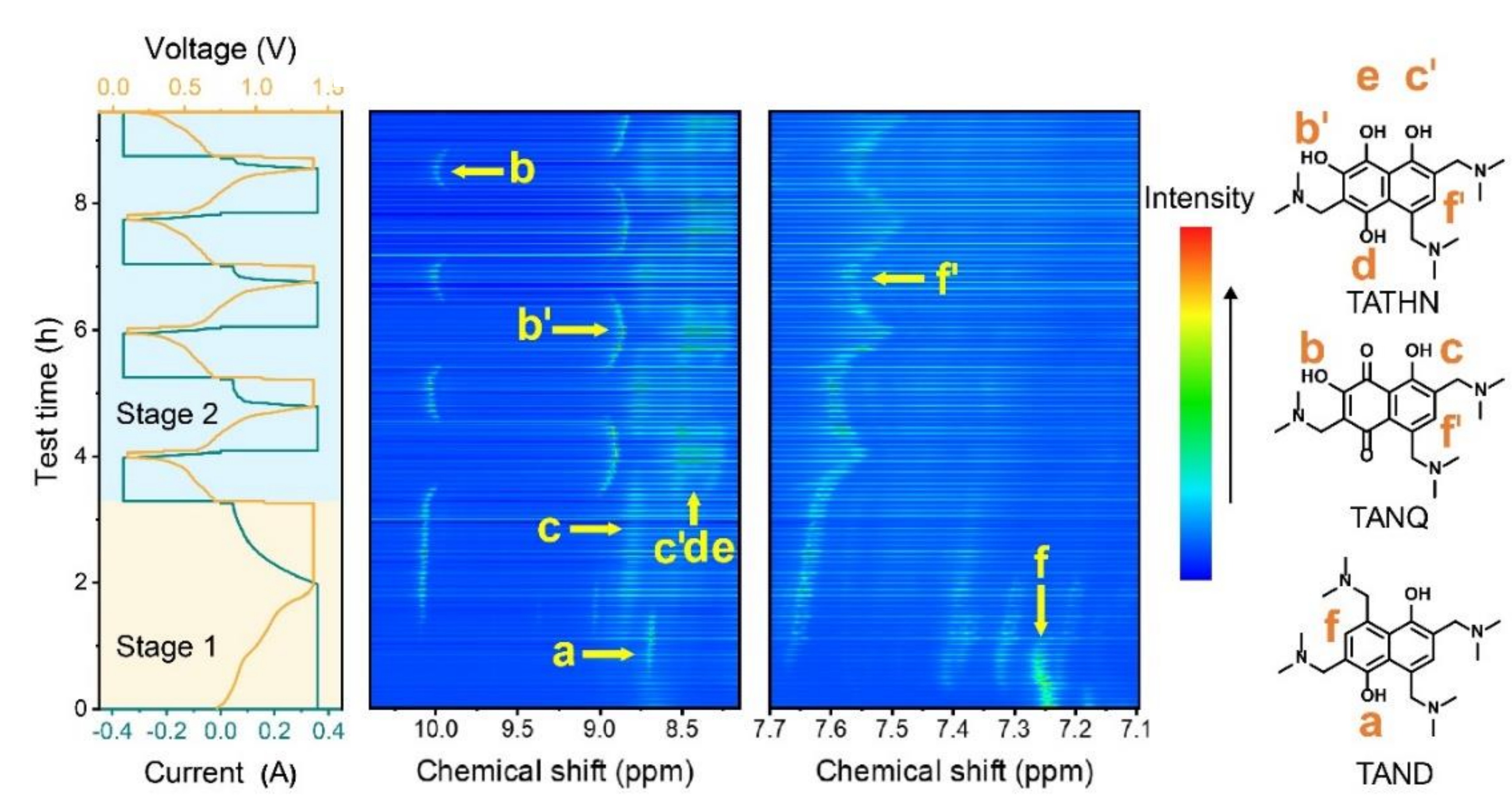

Fig. 4 In situ ^1H NMR spectra of the TAND during the electrochemical process.

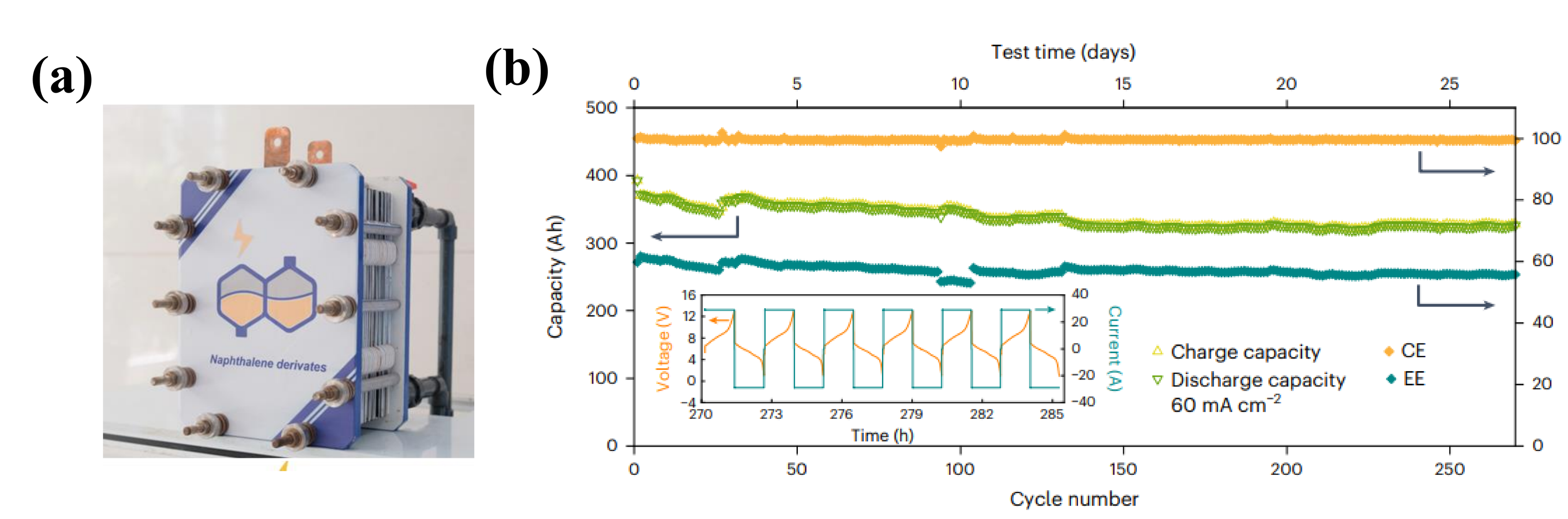

Fig. 5 (a), Naphthalene-based flow battery stack and (b), The system capacity and efficiencies of the pilot-scale stack based on a 0.6 M TANQ-based cell.

References

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