

## Novel organic materials for non-aqueous redox flow batteries: implementation of triarylamine and phenazine core structures

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The rapid growth of the role of renewable energy sources dictates new requirements for the electrochemical energy storage devices. Among them, redox flow batteries (RFBs) are regarded as a promising technology, since their advantages of excellent scalability, low cost, easy fabrication and operation, long lifetime, and safety. Today inorganic RFBs are penetrating the market, however, low specific capacity in conjunction with with low electrochemical stability window of aqueous electrolytes ( $\approx 1.5$  V) and safety issues, hinders their wide-scale commercialization.

Herein, we studied a group of organic materials based on aromatic amines with general formulas of  $NPh_3R_nBr_m$  and  $N_2Ph_5R_nBr_m$  where  $R=-(OCH_2CH_2)_2-OCH_3$ . All the compounds demonstrated high solubility in MeCN, which potentially enables outstanding specific capacities approaching 134 Ah L<sup>-1</sup>. Compounds demonstrated one or two quasi-reversible electron transition processes with redox potential up to 0.6 V vs. Ag/AgNO<sub>3</sub> reference electrode, what makes them perspective catholyte materials. For the RFB investigation butylviologen perchlorate ( 0.75V vs. Ag/AgNO<sub>3</sub>, ~1.15 V battery voltage) was chosen as the redox pair. Firstly, the selection of the most appropriate electrolyte was performed: it was shown that the usage of the TBABF<sub>4</sub> and NaClO<sub>4</sub> produces the stable characteristics of RFB performance. Final RFB tests proved that the most promising systems are capable to exhibit 65% of maximum capacities and more than 95% Coulombic efficiency after 50 cycles.

On the next step we synthesized and investigated novel phenazine derivative with oligomeric ethylene glycol ether substituents as promising anolyte material. The designed compound undergoes a reversible and stable reduction at -1.72 V vs. Ag/AgNO<sub>3</sub> and demonstrates excellent (>2.5 M) solubility in MeCN. A non aqueous organic redox flow battery assembled using novel phenazine derivative as anolyte and substituted triarylamine derivative as a catholyte exhibited high specific capacity (~93% from the theoretical value on the first cycles), >95% Coulombic efficiency and good cycling stability.

To summarize, investigated materials establish themselves attractive for future research: obtained parameters open promising future directions for their usage as redox-active materials for non-aqueous RFBs.