

Versatile Electrochemical Approaches for Redox Active Polymer Flow Batteries

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Non-aqueous redox flow batteries (NRFBs) are a potentially viable alternative to their aqueous counterparts as they offer a wider range of redox active species and electrolytes available for their design.^[1] The larger electrochemical windows of organic solvents can be used to search for redox molecules with higher energy densities. However, NRFBs suffer from the lack of suitable membranes. Separating the redox active species in the electrolyte compartments by size-exclusion while allowing free flow of the supporting electrolyte presents a powerful alternative to the use of poorly-performing ion exchange membranes. This approach is made possible by the careful design and evaluation of soluble Redox Active Polymers (RAPs), together with nanoporous separators, as shown in Figure 1. RAPs made in our laboratories consist of a polymeric unconjugated backbone that is decorated with high energy density and highly stable redox active pendants that display facile electron transfer even in highly concentrated solutions.

We will present our advances towards implementing an all-organic RAP cell, as well as our work for understanding the dynamics of RAP solutions. Viologen polymers^[2] have served as an excellent test platform for understanding charge transfer and transport on RAPs using an array of micro- and nano-electrode techniques, hydrodynamic voltammetry, spectro-electrochemistry, computational analysis, and single-particle analysis.^[3] RAP reactivity can be modulated through inter-pendant interactions within the polymer backbone and through interactions with the electrolyte. We will discuss strategies in which these effects can be used to create flow-cell functionality from fundamental interactions at the nano-scale.

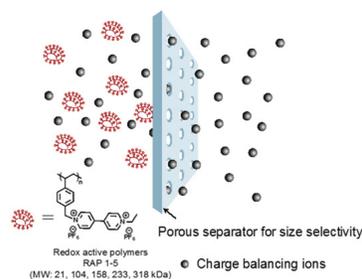


Figure 1. Size selective strategy for NRFBs

[1] R.M. Darling, K.G. Gallagher, J.A. Kowalski, S. Ha, F.R. Brushett. *Energy Environ. Sci.* **2014**, *7*, 3459.

[2] G. Nagarjuna, J. Hui, K. Cheng, T. Lichtenstein, M. Shen, J. S. Moore and J. Rodríguez-López. *J. Am. Chem. Soc.* **2014**, *136*, 16309.

[3] M. Burgess, K. Hernández-Burgos, B. H. Simpson, T. Lichtenstein, S. Avetian, G. Nagarjuna, K. J. Cheng, J. S. Moore and J. Rodríguez-López. *J. Electrochem. Soc.*, **2016**, *163*, H3006.



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