

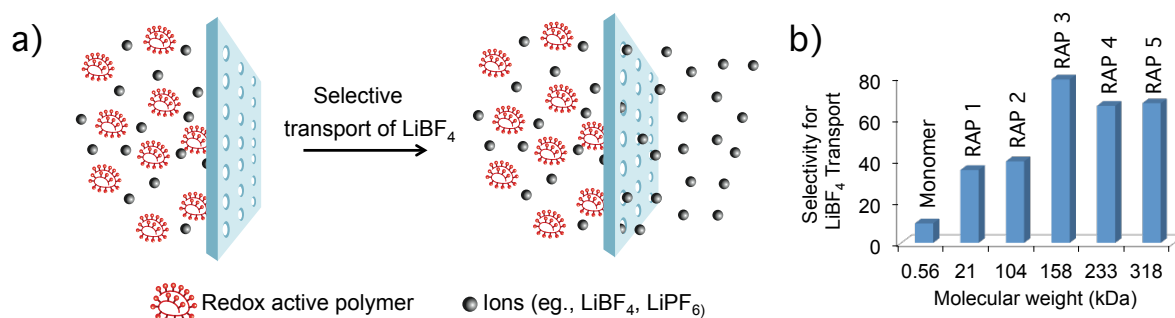
Nanohour

Wednesday, March 11, 2015, 3:00 pm

Beckman Institute – Room 4269

Redox Active Polymer Nanostructures for Size-Exclusion Based Transport in Non-Aqueous Redox Flow Batteries

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a) Schematic showing the diffusion of charge balancing ions while the redox active polymers are retained; b) selectivity for LiBF_4 transport across commercial off-the-shelf porous separator (Celgard 2325, pore radius 14 nm)

In order to completely rely on intermittent energy sources such as solar and wind energy there is a need for efficient energy storage systems. Recently, there has been a lot of interest in non-aqueous redox flow batteries (NRFBs) because of their potential for grid-scale energy storage applications. To improve the performance and enable the widespread utilization of NRFBs, the ionic conductivity across the electrolyte separator should be improved. Existing ion-exchange membranes show low ionic conductivity in non-aqueous solvents and also contribute to ca. 20-40% of battery cost. We have envisaged using commercial off-the-shelf (COTS) porous separators in NRFBs to enhance the ionic conductivity and reduce battery cost. The transport mechanism across porous separators is based on size-exclusion strategy. However, the challenge in testing this strategy is identifying the suitable redox active species that are easily varied in size, remain highly soluble, and exhibit good electrochemical properties.

In this work, we have identified poly(vinylbenzyl ethylviologen) as a suitable redox active polymer (RAP) to test this hypothesis. RAPs of different molecular weight between 21 and 318 kDa were synthesized and their electrochemical properties and transport across COTS porous separators were studied. Polymer size increased with increasing molecular weight up to 158 kDa and no significant change was observed with further increase in molecular weight. The selectivity for ion transport across these separators increased with increase in polymer molecular weight. COTS porous separators show ca. 70 times higher selectivity for charge balancing ions (Li^+BF_4^-) compared to high molecular weight RAPs. Thus the use of redox active nanostructures as electrode material enables the use of relatively inexpensive and high ion conducting COTS porous separators in NRFBs

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