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The investigation on the preparation and performance of highly selective and conductive porous ion conducting membranes for vanadium flow battery

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Vanadium flow batteries (VFBs) have received more and more attention due to their attractive characteristics of independently tuneable power and capacity, long cycle life, high safety, high efficiency and environmental benignity. A membrane plays the role of preventing cross-mixing of positive and negative electrolytes, while still allowing the transport of protons to complete the electrical circuit. An ideal membrane in a VFB should have features like high proton conductivity, high ion selectivity, high chemical stability and low cost. Recently, our group has succeeded in introducing porous nanofiltration membranes into VFBs, based on the idea of using pore size exclusion to realize V/H selectivity. A simple and effective solvent treatment method was developed to prepare porous membranes with tuneable morphology for VFBs. The pore structure of porous membranes was controlled by tuning the swelling force and cohesive force of polymers to optimize their performance in VFBs[4]. High ion selectivity together with excellent proton conductivity was obtained, thanks to the solvent induced shrinkage of pores. An impressive VFB performance with a CE of over 99%, and an EE of over 90% was obtained at 80 mA cm⁻², which is the highest value ever reported for porous uncharged membranes (Fig. 1). Based on this work, the solvent treatment was utilized to firstly create porous membranes with critically hydrophobic/hydrophilic phase separated like structures in VFBs by solvent-induced reassembly of a polymer blend system (Fig. 2). A highly phase separated membrane structure was created, composed of a highly stable hydrophobic porous matrix and hydrophilic interconnected small pores. The resultant membrane showed an excellent battery performance with a CE exceeding 99%, along with an EE over 91%, which was among the highest values ever reported. Therefore, solvent treatment is a simple and cost-effective but highly efficient method to prepare high-performance porous membranes for VFBs.

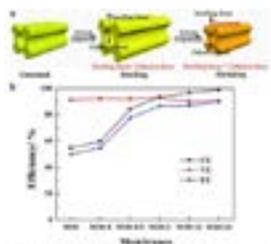


Fig. 1. (a) The structure of the pore in the membrane being prepared; (b) The relationship between CE and EE and the thickness of the membrane.

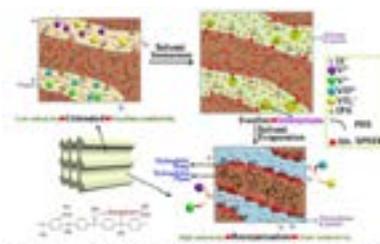


Fig. 2. The principle of the solvent-induced reassembly of polymer chains in the porous PEG-SPBEC blend membrane.

Biography

Wenjing Lu got her Bachelor degree (BSc) from Shandong University in 2014. She is presently a PhD student under the supervision of Prof. Xianfeng Li at Dalian Institute of Chemical Physics (DICP). Her work involves the membrane structure design and performance research of porous ion conducting membranes for flow battery applications.

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