Innovation in Ion-Selective Membranes for Electrochemical Energy Storage

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Abstract: Membrane materials for electrochemical energy conversion and storage devices play important roles in low-carbon technologies for achieving net-zero emissions. Next-generation ion-selective polymer membranes with low-cost production, high ionic conductivity and selectivity, and durability are required for large scale applications of electrochemical energy conversion and storage devices. I will present our recent work in the development of a new generation of ion-selective membranes and their applications in redox flow batteries for energy storage. A series of ion-conductive membranes were developed from polymers of intrinsic microporosity (PIMs) by incorporating ion-conductive groups into the polymers. Owing to their microporosity and ion-conducting functionality, PIM membranes present fast ion transport and high selectivity towards electrochemical active materials. The versatile chemistry of polymer membranes can be tailored on the molecular level to precisely tune the pore size and ion-conducting functionality to match the batteries with different redox chemistries. The new PIM membranes significantly boost battery energy efficiency and peak power density and enable stable operations of RFBs. Our membrane design strategy may inspire the development of a new generation of ion-exchange membranes for a wide range of electrochemical processes for energy and environmental applications.

Keywords: Energy Storage, Ion-exchange membranes, microporous polymers.