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Investigation of Ion and Water Transport in Block and Random poly(vinyl benzyl trimethylamine), poly(methylbutyline) Copolymers

Ashley M. Maes[a], Tsung-Han Tsai[b], Vito Di Noto[c], Andrew M. Herring[a]

[a]Department of Chemical and Biological Engineering, Colorado School of Mines, Golden CO, USA
[b]Department of Polymer Science and Engineering, University of Massachusetts, Amherst MA, USA
[c]Department of Chemical Sciences,University of Padova, Via Marzolo 1, I-35131, Padova (PD), Italy

Introduction.

Fuel cells show promise as alternatives to current transportation technology and portable energy devices as focus shifts towards more a sustainable energy economy. Alkali anion exchange membrane (AEM) fuel cells address current shortfalls of proton exchange membrane fuel cells, with the potential for direct use of methanol fuel and use of non-precious metal catalysts. Anion exchange membranes with properties that meet the demands of alkali fuel cell applications are not currently commercially available[1,2].

In this work, the effect of ion exchange membrane morphology on electrochemical performance and mechanical stability is investigated in hydrocarbon copolymers. PVBTMA-b-PMB polymers were synthesized with varied hydrophilic block lengths in order to induce varied morphologies. PVBTMA-ran-PMB polymers were also synthesized to probe the effect of copolymer organization on morphology and membrane performance. The organization and uptake of water within the membrane is also investigated.

Experimental Methods.

The morphology at various length scales of the membrane samples was studied with small and wide angle x-ray scattering at the Advanced Photon Source at Argonne National Laboratories. Humidity and temperature were controlled during scattering experiments.

Water uptake was quantified using dynamic vapor sorption (DVS) apparatus. Conductivity measurements were collected using electrochemical impedance spectroscopy (EIS) with data from a multi-channel potentiostat under temperature and humidity control. These measurements were be used to determine the effects of water content on membrane performance. Conductivity measurements were performed on membranes both with bromide counter-ions and hydroxide counter-ions.

The effect of morphological differences in the samples on electrical properties was investigated through broadband electric spectroscopy (BES). The complex impedance spectra of membranes were measured in the frequency range from 10 mHz to 10 MHz under temperatures from 5 to 155 °C with a Novocontrol Alpha-A analyzer with methods described in Di Noto et al.[3] Membranes were tested under hydrated conditions.

References.

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