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Proton exchange membranes prepared from cross-linked and multi-block copolymers based on poly (arylene ether ketone)

Poly (arylene ether ketone)s (PAEKs) are synthesized in cross-linked and multi-block copolymer structures. The chemical structure of the oligomers and the polymers synthesized is identified using ^{1}H - and ^{19}F- nuclear magnetic resonance spectroscopy, attenuated total reflection Fourier transform infrared spectroscopy and gel permeation chromatography. Cross-linking of the sulfonated poly (arylene ether ketone) (SPAEK) enhances their dimensional and mechanical stability. Sulfonated mesoporous benzene-silica (SMBS) hygroscopic conductors are embedded in the membranes to lessen their dehydration in the low humid environment. The effects of sulfonation degree (SD) and hygroscopic conductors on the membranes properties are analyzed. The prepared cross-linked SPAEK (CSPAEK) membranes are thermally stable up to 250°C without any chemical degradation. While the CSPAEK membranes containing hygroscopic proton conductors exhibit superior conductivity to that of Nafion®117, those with a cross-linking percent of less than 20% showed lower methanol permeability. Although the water uptake of the composite membranes is higher than that of the pristine membranes, no mechanical failure is observed. In the synthesis of multi-block copolymers based on PAEK, the development of distinguished hydrophobic-hydrophilic phase separation is confirmed by small-angle X-ray scattering spectroscopy. The proton conductivity and water uptake along with the thermal, mechanical, oxidative stabilities are measured to investigate the effect of the polymer structure on the membrane properties. The proton conductivity of the multi-block copolymer membrane is higher than that of the randomly sulfonated poly(ether ether ketone) copolymer (SPEEK), while its water uptake was lower than SPEEK. It results from much more distinct hydrophobic-hydrophilic phase separation formed in the multi-block copolymer membrane than the random one. The ion cluster dimension of the multi-block copolymer membranes is larger than that of the SPEEK membranes from the SAXS analysis. Also, the multi-block copolymer membranes show excellent oxidation stability compared to the random one due to the well-established phase separation.

Biography

Dukjoon Kim has completed his PhD from Purdue University and Post-doctoral studies from Lehigh University. He was the Execute Director of Korea Polymer Society and currently is the Director of BK 21 Program in SKKU. He has published more than 170 papers in reputed journals on functional polymer material files.

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