Recent advances in polymer electrolytes for electrochemical energy conversion.

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The polymers used for polymer electrolyte fuel cells have many demands on them. Fundamentally these materials are ion conductors and should have ionic conductivities >100 mS cm^{-1} under the conditions of operation. To date polymer electrolytes still achieve practical ionic conductivities by water mediated ion conduction. As membranes the material needs to be thin to enable a low area specific resistance (ASR) and to facilitate water diffusion from the anode to the cathode so that external humidification of inlet streams is not necessitated. In addition, the material must be an electrical insulator, be a barrier to fuel and oxidant and be mechanically and chemically stable under the transient operation of a typical fuel cell. For proton exchange membranes (PEMs) the primary chemical degradation mechanism is through attack by oxygenated radicals and so current PEMs are pefluorinated sulfonic acid (PFSA) polymers. For anion exchange membranes (AEMS) the primary chemical degradation mechanism is through attack by the hydroxyl anion, a strong nucleophile, and so these materials tend to be wholly hydrocarbon based with advanced cations designed to resist nucleophilic attack. The water transport in AEM fuel cells becomes more critical as water is both a product and a reactant in these systems. Our own work is used to illustrate how an experimental polymer is scaled up and processed into device ready films. Using developer feedback, we will the show how modifications to the polymer can tailor the material for specific devices. An interplay between cross-linking, ion exchange capacity, and polymer chemistry and morphology becomes apparent to achieve a successful outcome. Our group makes much use of environmental SAXS and WAXS to study membranes under fuel cell relevant conditions and we have recently begun to expand these studies to environmental GISAXS for catalyst layer relevant work.