Advances in polybenzimidazole (PBI) polymerization techniques and application in high-temperature polymer electrolyte membrane fuel cells (HT-PEMFCs)

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Polybenzimidazoles (PBIs) membranes have been investigated for their application in various electrochemical devices, including high-temperature polymer electrolyte membrane fuel cells (HT-PEMFCs). The most common method of PBI membrane synthesis involves dissolving the polymerized PBI in an organic solvent followed by casting and removal of the solvent, and finally doping the membrane in phosphoric acid. The Benicewicz group developed an alternative method, called the polyphosphoric acid (PPA) process, in which PBI is polymerized in PPA and cast directly from solution. A sol-to-gel phase transition is induced, resulting in PBI gel membranes that are imbibed in phosphoric acid. Advantages of the PPA process include higher acid uptake, greater conductivity, and better fuel cell performance. The main degradation mode of the PBI gel membranes in fuel cells was found to be from mechanical creep of the highly swollen gel membrane over time. A recent processing technique has been discovered in which a gel PBI membrane made in the PPA process undergoes a physical transformation into a dense PBI film, leading to unique properties. This presentation will highlight the advances with this recent technique in terms of structure-property relationships. In particular, the key membrane properties of tensile, creep and ionic conductivity will be discussed, as well as fuel cell performance.