

278a Near Net-Shape Fabrication of Nafion® Membranes for Fuel Cell Applications

Amanda Moster and Brian S. Mitchell

Nafion® is the foremost material used in polymer electrolyte membrane fuel cells, valued for its thermal and chemical stability, ionic properties, and mechanical strength. The properties of Nafion® can be modified by either making changes to the chemical structure or by altering the membrane formation or processing procedures. In this study, membranes were formed via near net-shape manufacturing. The effect of the process on material properties was determined. Powders were created from Nafion® pellets by mechanical milling at cryogenic temperatures. Milled powder was then mechanically pressed to form transparent membranes of optical clarity comparable to commercial membranes. These were further processed by hot isostatic pressing (HIP) at pressures of 45,000psi and temperatures as high as 110°C.

Differential scanning calorimetry conducted on milled powders showed two endothermic events. These agree well with previous studies and indicate that neither the ionic clusters nor the crystalline nature of the tetrafluoroethylene backbone are compromised by the milling process. Dynamic mechanical analysis of the membranes indicates that the level of membrane hydration during processing has a significant effect on material properties. Membranes HIPed following the removal of water with desiccant show mechanical properties and glass transition temperatures (T_g) comparable to a purchased membrane. When HIPed following storage at ambient conditions, significant changes in material properties are noted, including a shift in T_g to higher temperature.