Synthesis and Characterization of a New Class of Ceramic Proton Conducting Solid Electrolytes

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A new class of intermediate temperature proton conducting solid electrolytes is being developed and characterized. The goal of this research program is to overcome many of the low temperature limitations of polymer-based proton conducting membranes, such as Nafion, but yet not require the high temperature operating conditions of traditional ceramic oxide solid electrolytes. Hydrated polymer proton exchange membranes, such as Nafion, require significant levels of hydration in order to maintain their high proton conductivity and as such, they typically have maximum operating temperatures in the vicinity of 100°C. In addition, their thin film nature and water-based conduction medium lead to relatively rapid fuel crossover diffusion. Fuels such as methanol, which are highly soluble in water, rapidly diffuse across these thin membranes and as such severely degrade fuel cell operation efficiency. Similarly, high temperature solid oxide ion conducting electrolytes require operating temperatures in excess of 500 to 700 °C to achieve the requisite level of oxygen or proton conductivity to make them viable in a fuel cell. Such high operating temperatures typically limit their usefulness to stationary power supply operations where the fuel cell infrastructure required for such high temperature operation does not pose any weight performance limitations.

In this presentation, new research will be reported that seeks to develop intermediate temperature proton conducting membranes for use in proton exchange fuel cells. Such electrolytes are sought to achieve proton conductivities in the range of 10^{-5} to $10^{-3} (\Omega cm)^{-1}$ in the temperature range of 200 to 500 °C. New sulfide chemistries are being developed that seek to decrease the bonding energy of the proton and as such increase the proton conductivity compared to oxide-based materials. Glasses, glass-ceramics, and polycrystalline ceramics are being developed and our progress to improve the conductivity in these materials will be reported.