Electrochemical properties and processing of proton conductor membranes and electrodes

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Due to the finite availability of fossil-fuels and their detrimental impact on our world's climate, it is imperative that we find alternative sources for energy. One such energy source is hydrogen. H_2 can be produced renewably using sunlight and wind, as well as through conversion from bio-waste fuels, and then converted to electricity in fuel cells on demand in vehicles and in commercial, industrial, and residential power applications. In several of the above applications, hydrogen membranes play a key role. For example, in hydrogen production using bio-waste, separation of hydrogen from CO_2, produced by the water gas shift reaction, relies on selective permeation of hydrogen through a membrane. Likewise, in fuel cells, hydrogen is passed through a pure proton conducting membrane to react with oxygen and produce electricity. Operation in an intermediate temperature region (200 - 500 ^{o}C) has energy saving advantages, expected improved durability, and rapid start/stop times. While oxides provide the needed temperature stability, their resistance to proton migration in the bulk and incorporation at the electrodes becomes a significant barrier to their use. In this presentation, we will discuss our efforts to improve bulk proton transport with the aid of nano-scale thickness membranes fabricated by a sol-gel process. Additionally, we will present our research examining the origin of large electrode resistances, aided by the use of a model materials system, thin film deposition techniques, electrical characterization using impedance spectroscopy, and point defect modeling.