Hawai'i Natural Energy Institute Research Highlights

Electrochemical Power Systems

Proton Conducting Electrolytes for HT-PEMFC

OBJECTIVE AND SIGNIFICANCE: The objective of this project is to develop a novel inorganic electrolyte with high proton conductivity under high temperature and low humidity to be used as the catalyst layer of the high temperature proton exchange membrane fuel cell (HT-PEMFC) to overcome the issue of phosphoric acid (H_3PO_4) leaching. High temperature operation would facilitate the PEMFC system meeting with the U.S. DOE technical targets at performance, power and energy density, cost, and liability by inhibiting the poisoning effects of air pollution and fuel impurities and simplifing the water and heat management of the system.

BACKGROUND: PEMFC is considered a promising clean energy technology for the transportation and stationary applications. The contamiants in air and hydrogen fuel are big challenge for the Pt catalysts in the typical PEMFC when it is operated in the realistic atmosphere. The high temperature operation (150-200°C) of PEMFC has been considered as one of the potential solutions to mitigate the poisoning effects due to the high conversion rate or weak adsorption of the contaminants. The high temperature operation also facilitates the heat transport and the mass transfer of oxygen and hydrogen because the high temperature differential and the absence of liquid water in the cell, respectively. With those advantages, HT-PEMFCs would eliminate the humidifier and simflify the air and fuel supply and the cooling system. However, the current perfluorosulfonic acid (PFSA, Nafion®) polymer electrolytes are limited application below 90°C. The high temperature polymer PBI doped with H_3PO_4 (H_3PO_4/PBI) has been used as the PEM and the electrolyte in the catalyst layer of HT-PEMFC. But H_3PO_4 leaching is a big issue during operation, especially in the catalyst layer.

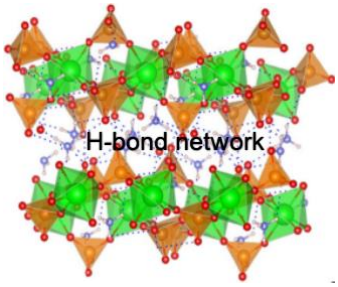

Figure 1. H-bond network in the layered structures of the inorganic proton conducting materials.

Recently, layered inorganic materials with "water in solid" have been developed as proton conducting electrolytes for the proton battery. The hydrogen bond switching among the ligand water provides a fast proton transport network in mutilayer structures (Figure 1). The proton conducting materals can also be used in the catalyst layers of the HT-PEMFC.

PROJECT STATUS/RESULTS: At HNEI, a novel inorganic layered structure material is being developed for HT-PEMFCs as proton conducting electrolyte. The candidate will be integrated into the in the catalyst layers of high-temperature membrane electrode assemblies (HT-MEA) of the contaminant tolerant fuel cells for harsh environments.

The capability to synthesize, treat, and handle the materials has been established. A concept paper was submitted to U.S. DOE for seeking potential funding.

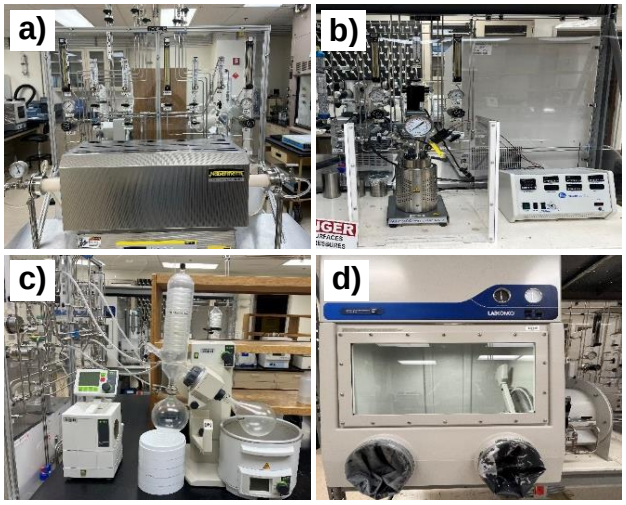

Figure 2. Tub furnace (a), high temperature and high pressure reactor (b), rotating evaporator (c), and glove box (d) for synthesizing, treating, handing, and storing the novel proton conducting material.

The project is ongoing as the multilayer material will be synthesized; the structure, composition, and proton conductivity will be characterized; the material will be integrated into the catalyst layers of HT-MEAs and the performance of HT-PEMFC will be evaluated at 150-200°C.

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