A Novel Process to Fabricate Stable Bipolar Membranes for the Next Generation of Hydrogen Fuel Cells

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All paths to a sustainable planet must pass through hydrogen-based fuel cell systems to replace our fossil-fuel dependent economy. In addition, the low weight, high power densities, and broad operation conditions of hydrogen fuel cells make them very attractive for numerous applications, such as unmanned submarines, drones, wearable power systems, and space stations in the US Armed and Space Forces. Despite their tremendous promise, hydrogen fuel cells technologies have not lived up to their potential. The lackluster application of fuel cells today is due to the need for expensive catalysts, high purity gases, and complicated water handling systems. Bipolar membranes facilitate the use of inexpensive catalysts and eliminates water handling and gas purification systems. Unfortunately, today's bipolar membranes are not suitable for the harsh environments encountered in a hydrogen fuel cell. In this project, a radically new approach to fabricate stable bipolar membranes with the chemical, mechanical, and thermal stability of the benchmark Nafion™ type proton exchange membrane (PEM). Bipolarity was created within the pores of a Nafion™ membrane by carefully choosing the intercalating cations and manipulating the pore properties. The bipolar conversion was demonstrated through salt uptake, Helium Ion Microscopy (HIM), and X-ray Photoelectron Spectroscopy (XPS). Bipolar membranes synthesized in this project are estimated to have water splitting rates ~6 orders of magnitude greater than conventional bipolar membranes. Utilizing these bipolar membranes will revolutionize the hydrogen fuel cells industry and bring us closer to a more sustainable planet.

Awards Won:

Fourth Award of $500

Patent and Trademark Office Society: Second Award of $500