Advanced Electrolysis for Renewable Energy Conversion and Storage

ABSTRACT

The utilization of renewable energy has substantially driven more investments into electrolysis technologies. As renewable energy emerges and penetrates further into the energy market, the storage of surplus “off peak” electricity has received widespread attention. An electrolyzer can utilize “off peak” electricity from solar or wind farms to produce hydrogen or other fuels. These chemicals can then be operated in a fuel cell mode to generate electricity when needed or used for other industrial applications. It is estimated that the water electrolyzer market can increase up to 300 GW over the next two decades. The power to gas market alone is poised to become a multi-billion-dollar market for on-site water electrolysis systems over the next decade.

However, current hydrogen production from electrolysis comprises only a small fraction of the global hydrogen market due to the high costs that result from expensive materials even if “free” electricity from renewable energy can be acquired. Giner has been a world leader in researching, developing and manufacturing water electrolyzers and reversible fuel cells. We have been striving to address the challenges of these materials (catalyst, membrane, and bipolar) to improve electrolyzers’ performance, extend their lifetimes, and lower their capital costs. These efforts include: 1) lowering platinum-group metal (PGM) catalyst loading; 2) discovering non-precious metal catalysts; 3) improving membrane durability; 4) increasing corrosion resistance of separators and other hardware.

In addition to water electrolysis for hydrogen production, electrochemical synthesis of ammonia and CO2 conversion to hydrocarbon fuels have also been extensively investigated at Giner. Advanced catalysts have been developed to enhance the conversion rate and boost the process efficiency. For example, the electrochemical production of ammonia from nitrogen and water has thus led to tremendous energy savings compared to the conventional Haber-Bosch process. The produced ammonia can be used as low-cost energy carrier for fuel cell vehicles. Some of these advances have been applied in our electrolyzer products, from small lab hydrogen generators to MW stacks. The performance and efficiency of our electrolyzers are thus tremendously improved. The development and deployment of these MW electrolyzer stacks will cultivate the large-scale application of a variety of renewable energy. Due to their high energy density and reduced cost, the electrolysis technologies may become strongly competitive and complementary to rechargeable batteries for renewable energy storage.

BIOGRAPHY

Dr. Hui Xu is Technical Director of Energy Conversion Materials at Giner Inc. He earned his Ph. D degree in chemical engineering from University of Connecticut in 2005. He subsequently pursued his postdoctoral studies at Los Alamos National Laboratory from 2006-2008, working on advanced electrode design and characterizations for low temperature polymer electrolyte membrane (PEM) fuel cells. He worked in Fuel Cell Energy, Inc. for three years, working on components design for high temperature molten carbonate fuel cells (MCFCs), prior to joining Giner in 2010. In his capacity at Giner, he oversees a variety of materials development including catalysts, membranes, electrodes, electrolytes, and bipolar plates, for a broad range of energy technologies, including low and high temperature fuel cells, water electrolyzers, electrochemical capacitors, and high energy density batteries. Dr. Xu is a recognized expert in fuel cell and electrochemical engineering. He is the principal investigator of multiple projects funded by DOE (EERE and ARPA-E), DOD, NASA, USDA and other industrial agencies, and has secured ~ $18 million research funding for Giner in past 5 years. His research scope covers hydrogen production and storage, ammonia synthesis, CO2 conversion, Li-S and Li-Air rechargeable batteries. He has authored 30 peer-reviewed journal publication and three patents.