Journal of Electrochemical Energy Conversion and Storage

Guest Editorial

Special Section on Mass and Charge Transport in Fuel Cells and Metal-Ion Batteries

Given the increasing energy demand and carbon dioxide emission, countries all over the world are vigorously developing sustainable and clean energy. Fuel cells and metal-ion batteries that directly convert chemical energy into electric energy have been receiving ever-increasing attention for energy conversion and storage in several applications such as portable, mobile, and stationary applications. Nowadays, not understanding mass and charge transport in fuel cells and metal-ion batteries, which results in low performance and durability, are still challenges for their large-scale commercialization. For example, the insufficient interaction of catalyst/ionomer/reactant as a result of fuel cells lacking the ion-conducting, reactant-delivering, or proton-conducting pathways leads to the deactivated triple-phase boundary. Meanwhile, the metal-ions transport in the interface of solid active materials and electrolyte, and the charge transport including ions transport in the electrolyte, and electron transport in the solid phase, are not well known in advanced metal-ion batteries. An ideal electrode architecture that boosts the performance and durability of cells and batteries needs the electrode design to meet all the requirements of electrochemical kinetics and mass and charge transport characteristics.

Some of the theories and methods were proposed in this special section to address the abovementioned problems and challenges. Sun et al. proposed a two-dimensional two-phase mass-transport model involving Knudsen diffusion to gain insight into the mass and charge transports in ordered catalyst layer of direct methanol fuel cell (DMFC). They demonstrated that higher porosity near the oxygen diffusion layer facilitates the oxygen transport, and the optimal porosity is obtained by balancing mass and charge transport resistances in the ordered catalyst layer. Li et al. investigated the species transfer in DMFC using a liquid–vapor two-phase model, and discovered that the mass transfer resistance of liquid and gas is more sensitive to the pore size distribution than the thickness of electrode. The effects of structural parameters of the reactant flow channel and the cooling channel on proton exchange membrane fuel cell (PEMFC) performance were analyzed by Yang et al. via a multiphase PEMFC model. The simulation results demonstrated that the rib width between the above two channels has the greatest influence on the cell performance. Inoue et al. designed a 3D cathode catalyst layer which can increase the surface area and decrease the oxygen transfer resistance, thus obtaining the enhanced fuel cell performance. Three different nonprecious electrocatalysts were synthesized to promote the commercialization of fuel cells from the perspective of cost, performance, and durability. A corncob derived porous carbon composite was prepared by Yang et al. through a scalable and cost-effective calcination method to serve as the high-performance anode of lithium ion batteries (LIBs). The porous structure can act as the free space, which can easily accommodate the moment of electrons and Li^+ during the delithiation/lithiation process, thus improving the LIBs performance. Wang et al. designed a nano-cellulose fiber and graphene oxide (NCF/GO) coating to promote the uniform flux of Li^+ and restrain the growth of Li-dendrite in LIBs. The durability of LIB with NCF/GO coated separator extended about 40% than the battery with bare polyolefin separator. MXene nanoflakes confined within multichannel carbon nanofibers (MXene@MCNF) had been successfully synthesized by Zhang et al., which can be used as a robust cathode electrocatalyst for Li-S batteries. The multichannel hollow structure of MXene@MCNF can inhibit the outward dissolution of polysulfides via the physical confinement caused by their abundant pore structures, which can efficiently enhance the cell performance.

We would like to express our warm gratitude to Prof. Wilson K. S. Chiu, the Editor-in-Chief of the ASME *Journal of Electrochemical Energy Conversion and Storage*, and all the contributors to this special section. Thank you for submitting the latest high-impact work to understand mass and charge transport in fuel cells and metal-ion batteries. We believe that this special section provides an opportunity to assist the commercialization of fuel cells and metal-ion batteries in the future.

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