Preface

Polymer electrolyte fuel cells (PEFCs) or proton exchange membrane fuel cells (PEMFCs) have been suggested as alternatives to replace many existing energy conversion technologies, including internal combustion engines and batteries. The most significant advances in PEFC technology achieved in the last decade have occurred in areas related to automotive applications, namely cold-start capabilities, enhanced durability and better understanding of water management and mass transport losses.

This volume of Modern Aspects of Electrochemistry is intended to provide an overview of advancements in experimental diagnostics and modeling of polymer electrolyte fuel cells. Chapters by Huang and Reifsnider and Gu et al. provide an in-depth review of the durability issues in PEFCs as well as recent developments in understanding and mitigation of degradation in the polymer membrane and electrocatalyst.

Enabling cold start, the startup of PEFC stacks from subzero temperatures, is a very important capability achieved only within the last few years. Tajiri and Wang provide a tutorial overview of the requirements for cold start, and provide a summary of experimental diagnostics and cold-start modeling studies.

Chapters 4–6 address specific diagnostic methods in PEFCs. Martin et al. provide a detailed review of methods for distributed diagnostics of species, temperature, and current in PEFCs in Chapter 4. In Chapter 5, Hussey and Jacobson describe the operational principles of neutron radiography for in-situ visualization of liquid water distribution, and also outline issues related to temporal and spatial resolution. Tsushima and Hirai describe both magnetic resonance imaging (MRI) technique for visualization of water in PEFCs and tunable diode laser absorption spectroscopy (TDLAS) for measurement of water vapor concentration in Chapter 6.

Diffusion media (DM) are prone to flooding with liquid water. Although the DM is an essential component of PEFCs that enable distribution of species and collection of current and heat, little was known about capillary transport in DMs until recently. In Chapters 7 Gostick et al. provide a description of liquid water transport in porous DM due to capillarity and describe experimental techniques used to characterize DM properties.
The final two chapters discuss modeling of PEFCs. Mukherjee and Wang provide an in-depth review of meso-scale modeling of two-phase transport, while Zhou et al. summarize both the simulation of electrochemical reactions on electrocatalysts and the transport of protons through the polymer electrolyte using atomistic simulation tools such as molecular dynamics and Monte Carlo techniques.

Each chapter in the volume is self-contained; therefore they do not need to be read in a certain order.

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U. Pasaogullari  
*University of Connecticut, Storrs, CT, USA*

C.-Y. Wang  
*The Pennsylvania State University, University Park, PA, USA*
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