Preface

The ultimate goal of this book is to provide an integrated view of the basic theory, materials science, and engineering of gas transport in solid oxide fuel cells (SOFCs). Further, this book will provide an invaluable, contemporary reference for the development of fundamental theory and experiment, advanced experimental measurement techniques, and industrial applications of gas diffusivity in solid oxide fuel cells.

Interest in fuel cell technologies has been motivated by their function: directly converting stored chemical energy into electrical energy without combustion and emission of pollutants, such as nitrogen oxides (N_xO_y). These devices can overcome combustion efficiency limitations since the operation of fuel cells does not necessarily involve the Carnot cycle, thus reducing the emission of pollutants. Compared with other types of fuel cells, solid oxide fuel cells have shown clear advantages over other systems, since hydrogen, hydrocarbons, carbon monoxide, and carbon can be utilized as constituent fuels. The major disadvantage of SOFCs is their high operation temperature, which can reach 1000 °C. At such high temperatures, few materials can function effectively as electrolytes or electrodes. This feature of SOFCs increases their operation and fabrication costs, and hinders their application in rapidly developing areas of application, such as in portable power and automobile power device applications. The impedance of SOFCs, including the activation and concentration polarizations of electrodes and the Ohmic loss of electrolytes, increases sharply with decreasing operating temperatures. To reduce the impedance, fundamental comprehension of the mechanism of gas diffusion through the electrode and that of gas transport between the electrode and the electrolyte is necessary. Mechanisms and mathematical models of gas diffusion are discussed in detail in the first chapter of this book.

Several techniques for directly measuring gaseous diffusivity have been developed in recent years. These techniques allow gas transport coefficients to be accurately evaluated. The results of these measurements help to optimize the configuration of solid oxide fuel cells, including the surface properties of electrodes and the structure of electrodes and electrolytes, as well as the techniques for preparing electrolytes. Recent theoretical and experimental advancements in these measurement techniques are discussed in the middle chapters of this book.

Gas diffusivity of electrodes in solid oxide fuel cells drops rapidly with reducing operation temperatures. This loss of diffusivity cannot be compensated through the optimization of the configuration of the fuel cell. Therefore, the key to lowering the operation temperature of solid oxide fuel cells is the development of high-efficiency electrodes. The role of gas diffusivity measurement techniques in the exploration of novel electrode materials are also explored in the middle chapters of this book. Then, the book focuses on the strategies of realizing advanced solid oxide fuel cells with improved gas transport. This chapter presents an overview of novel porous electrode materials, and the techniques allowing for the rational design of electrode microstructure with highly efficient gas transport parameters, including porosity, tortuosity, etc. Finally, an outlook on research and development of low-temperature solid oxide fuel cells is presented.

http://www.springer.com/978-3-319-09736-7

Gas Transport in Solid Oxide Fuel Cells
He, W.; Lv, W.; Dickerson, J.
2014, XIV, 75 p. 47 illus., 41 illus. in color., Softcover
ISBN: 978-3-319-09736-7