Electrocatalysis of Direct Methanol Fuel Cells

This multi-author edited volume covers many aspects of the direct oxidation methanol fuel cell technology, mostly focused on the development of electrocatalysts, catalyst supports, proton exchange membranes, electrocatalysis in alkaline media, etc. The editors, who work at the Institute for Fuel Cell Innovation of the National Research Council, Canada, seem to be quite knowledgeable in the field.

The book is divided into 14 chapters written by experts in the field. The preface by the editors emphasizes the importance of direct methanol fuel cell technology in general, since methanol is a renewable fuel. Chapter 1, by researchers of the CNR-ITAE Institute, Italy, discusses the history, status, and perspectives of direct methanol fuel cells (DMFCs). The chapter covers all aspects of DMFCs, including principles, performance, efficiency, fuel utilization, catalysis, mechanism, proton exchange membranes (PEMs), alkaline membranes, cell construction, high-temperature operation, commercial players in the field, etc. Although the chapter is reasonably well-referenced (225 references), the authors seem to be unaware of two fundamental and frequently cited works on DMFC technology pioneered by the NASA Jet Propulsion Laboratory (JPL) and the University of Southern California (USC) group (*J. Power Sources* **1994**, *47*, 377, cited more than 200 times, and US Patent 5,599,638, February 4, 1997). In fact the highly effective Pt–Ru anode catalyst and PEM-based membrane electrode assemblies were developed by the JPL-USC team. There is only a cursory reference (Ref. [13], a symposium abstract) to the work of JPL on the original technology. However, JPL's further work on the development of a miniature fuel cell for cell phones is mentioned (Refs. [165, 169]). An important conference proceedings volume on DMFCs (2001–2004), published by the Electrochemical Society Inc. and edited by Narayanan, Gottesfeld, and Zawodzinski, is also ignored. Interestingly, the last chapter of the book cites some of these important references in the context of fuels other than methanol.

A series of thematically similar chapters on electrocatalysts (Chapters 2–9) discuss methods for the synthesis of nanostructured anode and cathode catalysts, catalyst structures, the influence of particle size, supports, impregnation methods, synthesis methods, and protocols for characterization and activity validation of electrocatalysts using a variety of spectroscopic methods such as XRD, TEM, SEM, AFM, XPS, LEED, AES, X-ray absorption, etc. Aspects of methanol oxidation at the anode and oxygen reduction (ORR) at the cathode are discussed, including evaluation of electrocatalytic activity, active surface area, etc. State-of-the-art catalysts and catalyst loadings are covered, with some emphasis on measurements using various electrochemical techniques. Combinatorial and high-throughput screening methods for DMFC electrocatalysts are also discussed, including methods for the analysis of data. State-of-the-art electrocatalysts for practical DMFC use are also covered. The topics discussed include different methods of catalyst preparation, membrane electrode assembly (MEA) fabrication, evaluation methods, durability and lifetime issues, membrane and crossover aspects, platinum-based electrocatalysts, methanol-tolerant cathode catalysts, and electrocatalysts on carbon nanotube or mesoporous carbon supports. As expected, there is quite a bit of overlap between the topics in these chapters and duplication of references.

Chapter 10 is devoted to proton exchange membranes for DMFC. Membranes formed by polymerization of various sulfonated monomers are discussed, as well as polymer electrolytes including Nafion-H, sulfonated aliphatic polymers, sulfonated polyaryl ether polymers, and others. However, the expected discussion of low-crossover PVDF-PSSA semi-IPN membranes is conspicuously absent. Chapter 11, co-authored by one of the editors, covers fabrication and optimization of membrane electrode assemblies at full cell level. Chapter 12 is mainly concerned with current distribution aspects of DMFCs and with modeling techniques pertaining to variables and parameters of DMFC such as mass transport, air flow, crossover, water flux, etc. Chapter 13 is a stand-alone contribution on electrocatalysis in direct methanol alkaline fuel cells. The limitation of the technique is the CO_2 poisoning of the alkaline electrolyte. Lastly, Chapter 14 discusses direct oxidation fuel cells using other liquid fuels, such as ethanol, formic acid, hydrazine, dimethyl ether, dimethoxymethane, trimethoxymethane, tetramethylorthocarbonate, etc.

In summary, the book gives recent snapshots of various aspects of direct methanol fuel cells. It is by no means exhaustive, and has missed some salient works in the field. Furthermore, the way in which the chapters are structured leads to significant overlap and repetitions. In spite of these shortcomings, the book is useful to practitioners in the field.

G. K. Surya Prakash, George A. Olah
Loker Hydrocarbon Research Institute and
Department of Chemistry
University of Southern California (USA)

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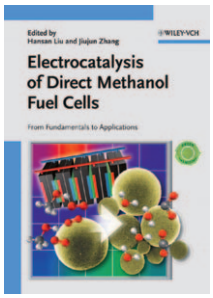

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