International Journal of Innovative Computing, Information and Control
Volume 7, Number 12, December 2011

ICIC International ©2011 ISSN 1349-4198
pp. 6991–7002

AN EXTENDED MODEL OF THE DIFFUSION BEHAVIORS OF AN ELECTROCHEMICAL SYSTEM

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Received January 2010; revised May 2010

Abstract. *The equivalent circuit models (ECMs) used to electrochemical impedance spectroscopy (EIS) or ac impedance testing are commonly employed for determining fuel cell properties and diffusion behaviors in an electrochemical system are proposed. By applying a theoretical approach, the criterion for deciding the appropriate parameters of the extended model is presented. Then, given the transformation rules, the extended model is transformed into electrical equivalent circuits (EECs) by introducing the constant phase element (CPE) as the electrical element. Corresponding with the physicochemical phenomena of the system investigated, the modeling methodology can provide a suitable EEC for modeling the EIS and then give physical a understanding of the diffusion behavior of the system. Afterward, the practical applications of two different electrochemical systems are given to demonstrate the reliability of the extended model in the analysis of the diffusion, particularly during the actual operation. The results indicate the availability and the accuracy of the proposed extended model for modeling and interpreting the diffusion behaviors of an electrochemical system.*
Keywords: Electrochemical impedance spectroscopy (EIS), Electrical equivalent circuit (EEC), Physicochemical phenomena, Theoretical approach

1. **Introduction.** Depletion of petroleum reserves, global warming, and concerns about energy security have inspired the search for new energy sources besides petroleum. Fuel cells are being developed with increasing intensity to replace or support batteries in portable applications from the sub-watt range to some hundred watts. Recently, many electrochemical systems such as the proton exchange membrane fuel cell (PEMFC), the direct methanol fuel cell (DMFC) and the solid oxide fuel cell (SOFC) have been developed as new energy sources [1-3]. To improve the system performance and optimize the ambient conditions, it is necessary to characterize the interaction of an electrochemical system as distinct and analyzable information. However, the conventional method to measure the output potential and current is insufficient to describe the physicochemical dynamics of an electrochemical system clearly. Therefore, the electrochemical impedance