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Orderly sandwich-shaped graphene oxide/Nafion composite membranes for direct methanol fuel cells

Li Sha Wang, Ao Nan Lai, Chen Xiao Lin, Qiu Gen Zhang, Ai Mei Zhu, Qing Lin Liu*

Department of Chemical & Biochemical Engineering, The College of Chemistry and Chemical Engineering, Xiamen University, Xiamen 361005, P. R. China

Corresponding author: Qing Lin Liu (Liu QL), E-mail: ql Liu@xmu.edu.cn, Tel: 86-592-2188072, Fax: 86-592-2184822

Abstract

A novel type of graphene oxide (GO)/Nafion composite membrane is fabricated and used as a proton exchange membrane for direct methanol fuel cells (DMFCs) in this article. The membranes are prepared by depositing GO nanosheets on the surface of recast Nafion® 117 via a layer-by-layer (LbL) procedure using 1, 4-phenyldiamine hydrochloride (PDHC) as the cross-linker. This approach prevents the GO nanosheets from dissolving in water and imparts the composite membranes a good stability. The methanol permeability of the composite membranes is lower than that of recast Nafion® 117 measured under the same conditions. The composite membrane with 80-layered GO nanosheets exhibits a value of $6.7 \times 10^{-8} \text{ cm}^2 \text{ s}^{-1}$ at 30 °C, which is two orders of magnitude lower than that of recast Nafion® 117. In addition, the relative selectivity of the composite membranes is 5 times higher than that of recast Nafion® 117. The endurance time of the composite membranes in Fenton's reagent is 10 times longer than that of Nafion. Single cell evaluation using the composite membrane with 50-layered GO showed an open circuit voltage (OCV) of 0.67 V. A maximum power density of 64.38 mW cm^{-2} at a current density of 200 mA cm^{-2} can be achieved at 60 °C.

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