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

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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 $\times 10^{-8}$ cm^2 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.