FACILE ONE-STEP HYDROTHERMAL SYNTHESIS OF NICKEL-INCORPORATED-NITROGEN-DOPED CARBON FOR DIRECTMETHANOL FUEL CELLS

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The urgent need to mitigate carbon emissions from conventional fuels has driven the development of efficient and low-cost energy conversion devices. Direct methanol fuel cells (DMFCs) are promising candidates due to their high energy density, potential for low-cost operation, and environmental benefits. However, their commercialization is hindered by reliance on expensive, CO-susceptible noble-metal catalysts. To address this challenge, the strategic design of non-noble multi-metallic catalysts has emerged as a critical approach. Herein, we report a facile, one-step hydrothermal synthesis method for producing a nickel-incorporated-nitrogen-doped carbon catalyst (Ni–NC) derived from nickel acetate, glucose, urea, and potassium hydroxide. The synthesized catalyst was characterized using scanning electron microscopy and X-ray diffraction. The synergistic integration of nickel species and nitrogen-doped carbon creates a multifunctional anode material exhibiting excellent methanol oxidation activity. Cyclic voltammetry measurements reveal that the Ni–NC catalyst exhibited a high current density of approximately 75 mA cm^{-2} using a 1 M KOH + 1 M CH_3OH solution as the electrolyte. The Ni–NC catalyst also demonstrates robust performance under varying operational conditions, maintaining current densities ranging from 66.6 to 76.3 mA cm^{-2} at scan rates ranging from 10 to 100 mV s^{-1}, and achieving an optimal value of 75.15 mA cm^{-2} at a methanol concentration of 1.5 M. Furthermore, the Ni–NC anode shows remarkable stability, with negligible activity loss over 500 cycles. This study presents a highly active, durable, and cost-effective catalyst system, advancing the development of practical non-precious-metal anodes for DMFC applications.