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Polyethylene glycol Assisted One-pot Hydrothermal Synthesis of $NiWO_4/WO_3$ Heterojunction for Direct Methanol Fuel Cells

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Abstract

A novel hetero-junction anode composed of $NiWO_4/WO_3$, formed at various metal molar ratios (Ni/W) and fabricated hydrothermally via simple salt solution addition method using polyethylene glycol, was characterized using XRD, TEM-SAED, N_2 sorptiometry, UV-Vis diffuse reflectance and FTIR spectrometry. Increasing NiO especially at the Ni/W ratio of 4 stimulates the develop of a tailored morphology (nanoplates/nanowires with crystallites size of 11 nm) with entailed mesoporous surface texturing values (S_{BET} = 100.7 m^2/g and V_p = 0.186 cm^3/g) exceeding those exhibited at Ni/W ratio of 1 and 2 and rather shows a monomodal type of pores at 3.5 nm. The electrocatalytic performances of all nanocomposites toward methanol oxidation (0.6 M) were examined in comparison with pristine NiO and WO_3 samples by cyclic voltammetry (CV), chronoamperometry (CA) and electrochemical impedance spectroscopy (EIS) measurements. Strikingly, the $NiWO_4/WO_3$ electrode; synthesized at Ni/W ratio of 4, shows higher current density exceeding those of NiW(1:1) and NiW(2 :1) by 3.4 and 2.6 fold, respectively. This pronounced electrocatalytic activity is mostly attributed to increasing the electrochemically active surface area of the former (16.9 cm^2) and superior mesoporous nanostructures, which facilitate not only the diffusional electrochemical kinetics but also the long term cycle durability towards the CO poisoning species. This encountered stability was also due to the strong interaction between Ni and W to form small $NiWO_4$ crystals of higher carrier density; as evaluated from the resistivity measurement, and to the hybridization with WO_3 moieties of high electron transport properties, as confirmed by the EIS results.

Keywords: $NiWO_4/WO_3$; Methanol oxidation; Electrocatalyst; Nanoplate/nanowires structure; EIS

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