Potassium Permanganate as an Oxidant for a Microfluidic Direct Formate Fuel Cell

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A simple Y-type microfluidic fuel cell (MFC) was constructed with graphite plates as the electrodes. Unlike the formic acid/potassium permanganate MFCs previously reported, an alkaline sodium formate solution (a fuel) and an acid potassium permanganate solution (KMnO₄, an oxidant) were adopted by our MFC. The flowing pattern in the main channel was a typical laminar flow. The effects of three parameters such as the concentrations of KMnO₄, the concentrations of H₂SO₄ (a supporting catholyte), and the flow rates of the reactants on the power output of the MFC were studied. The experimental results showed that the cell performance first improved but then decreased with increasing each parameter. The optimum MFC exhibited a maximum power density of 4.51 mW cm⁻² and a limiting current density of 6.67 mA cm⁻² with 50 mM KMnO₄, 0.5 M H₂SO₄ and a reactant flow rate of 30 mL h⁻¹. Although the power densities and limiting current densities of our MFC are not the highest in the MFCs using KMnO₄ as oxidants, its open circuit voltage remains at the top. Our work demonstrates that it is feasible to construct MFCs using alkaline formate and acidic permanganate solutions, which diversifies the types of MFCs containing KMnO₄ as the oxidant.

Keywords: Microfluidic fuel cells; Potassium permanganate; Supporting catholyte concentration; Reactant flow rate; Open circuit voltage

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