Catalytic Activity of Ni-YSZ composite as Anode for Methane Oxidation in Solid Oxide Fuel Cells

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Natural gas has been exploited as an available energy source for solid oxide fuel cells in recent years. However, the problem of carbon deposition that forms on nickel-based anodes by using direct methane results in performance failure of cells. It is well known that the catalytic partial oxidation of methane is a good solution to suppress carbon formation. Herein, we present an investigation of the catalytic activity of Ni/YSZ cermet anodes as a function of the CH₄/O₂ flow rate ratio ($1 \leq R_{in} \leq 5$). The behavior of methane catalytic activity was characterized using mass spectrometry (MS) and temperature-programmed oxidation (TPO). The catalytic activity of methane oxidation at 700 °C showed that Ni oxidation occurred at $R_{in} \leq 1.67$. A basic equilibrium to prevent carbon deposition and Ni oxidation occurred at $R_{in} = 2.5$, which exhibited the best activity among the Ni/YSZ electrodes. Through the electrochemical measurements and impedance spectroscopy analysis of the cell, it was proved that the cell possessed the lowest ohmic resistance and optimized output performance at $R_{in} = 2.5$. In addition, a stable cell operation at 0.9 V was guaranteed without serious degradation.

Keywords: Solid Oxide Fuel Cells, Catalytic Activity, CH₄/O₂ Ratio, Ni-YSZ Anode, Partial Oxidation

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