

Anodic Overpotential of the Cermet Anode and Electrocatlytic Behavior of Ceria-Based Electrolyte for Hydrocarbon Fuels

Yukito KATO*, Shigehiro KURODA*, Kazunori SATO*
Misa WATANABE**, Shigeaki SUGANUMA**, Yasue
TOKUTAKE**, and Michio HORIUCHI**

*Department of Materials Science and Engineering,
Nagaoka University of Technology, Nagaoka,
Niigata 940-2188, Japan
**Core Technology Research Laboratory
Shinko Electric Industries, Nagano 381-0014, Japan

Catalytic activity of the solid oxide fuel cell (SOFC) anode is important when hydrocarbon fuels are directly used. The nickel and yttria-stabilized zirconia (Ni/YSZ) cermet anode is currently used for the generation of a hydrogen-rich gas based on the steam reforming of methane in internal configuration. However, the endothermic nature of the steam reforming reaction results in a deactivation of the anodic oxidation reaction when the reaction temperature is decreased; the deactivation of the electrode reaction is mainly caused by the carbon deposition over the nickel surface. The development of a proper catalyst with the combination of a high oxide-ion conductor is therefore required for the direct oxidation of hydrocarbons.

The cell performance was investigated for a SOFC using samaria-doped Ceria (SDC) as the electrolyte combined with the Ni-based cermet anode and the $\text{Sm}_{0.5}\text{Sr}_{0.5}\text{CoO}_3$ (SSC) cathode. The anodic overpotential was measured for methanol, hydrogen, carbon monoxide, and their mixtures. The Ni-YSZ cermet anode was prepared by mixing fine oxide powders in an appropriate molar ratio and heating at 1350°C for 10 h in air. The SSC cathode was prepared by heating 1200°C for 5 h in air. The fuel cell was composed of the YSZ disk, 15 mm in diameter and 0.3 mm thick, and the electrodes. Anodic overpotential measurements were conducted using a three-electrode configuration by the current-interruption method.

Fig. 1 shows the cell performance for several fuels at 700°C. The cell performance was reduced most for carbon monoxide. The increase of the anodic overvoltage for carbon monoxide was caused by the carbon deposition over the surface of nickel due to the strong adsorption of carbon monoxide. Arrhenius plots of the inverse polarization resistance for several fuels are shown in Fig. 2. Increasing the ratio of carbon monoxide in the fuel increased the apparent activation energy for the anodic oxidation reaction. The decrease of reaction sites with a concurrent increase of diffusion resistance for the reactants seems to have reduced the cell performance. Electrode catalysts which enhance the electrocatalytic activity of the Ni-based cermet anode for the electrochemical oxidation of hydrocarbons are being investigated.

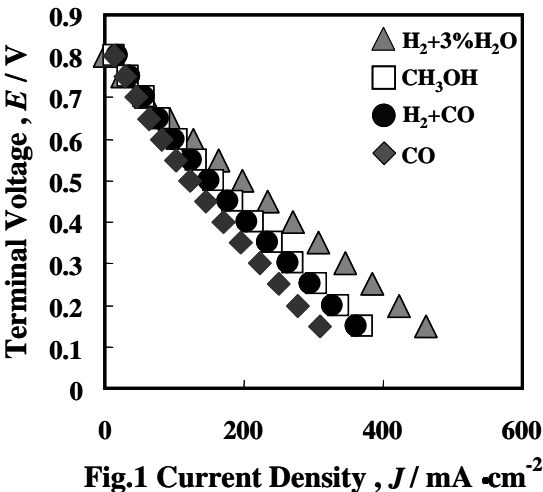


Fig. 1 Terminal voltage vs. current density for several fuels at 700°C.

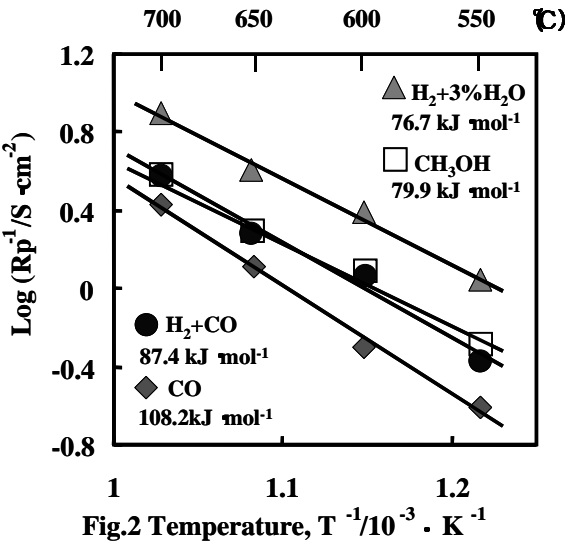


Fig. 2 Arrhenius plots of the inverse polarization resistance.