Advancing Direct Ethanol Metal-Supported Fuel Cells with a Perovskite Catalytic Layer

S. G. M. Carvalho, F. Tabuti [a], E. I. Santiago [a], R. Abe [b], R. M. Guimarães [b], A. Mohammed Hussain [c], Y. Miura [d], Y. Fukuyama [d] , F. C. Fonseca [a]

a Nuclear and Energy Research Institute, IPEN-CNEN/SP, University of São Paulo, São Paulo, Brazil
b Nissan do Brasil Automóveis Ltda, R&D Department, Rio de Janeiro, Brazil
c Nissan Technical Centre North America, Farmington Hills, MI, 48335, USA
d Nissan Motors Company, Ltd, Nissan Research Center, EV System Laboratory, Yokosuka-shi, Kanagawa, Japan

Direct ethanol fuel cells (DEFCs) offer significant potential to advance solid oxide fuel cell (SOFC) applications, leveraging ethanol as a renewable, energy-dense, and readily available fuel. Metal-supported SOFCs, known for their mechanical robustness, are particularly suited for demanding applications such as transportation. The integration of renewable ethanol fuel with durable metal-supported SOFCs presents a promising pathway for decarbonizing transportation in an economically viable and energy-efficient manner. However, challenges remain in enhancing the durability of these devices under ethanol operation.

In this study, we report a significant improvement in the stability of metal-supported SOFCs operating at relatively low temperatures (700 °C) with ethanol. This was achieved by incorporating a porous, highly active catalytic layer with a tailored microstructure, designed using processing parameters compatible with metal-supported SOFC technology. The catalytic layer, based on exsolved ruthenium from $LaCrO_3$ perovskite, demonstrated excellent catalytic properties and compatibility with SOFC components. Increasing the thickness of the catalytic layer further improved stability, while microstructural optimization using a pore former enabled continuous operation on ethanol for over 100 hours—a remarkable advancement compared to the rapid failure of as-received metal-supported SOFCs under ethanol. These advances represent a critical step toward the practical application of ethanol-fueled SOFCs in sustainable energy systems.