cbecimat26
26° Congresso Brasileiro de Engenharia e Ciência dos Materiais
22 a 26 de novembro de 2026
Costão do Santinho
Florianópolis-SC

Fabrication and characterisation of Ni-Fe-infiltrated mesoporous 8YSZ anodes for direct ammonia SOFCs

Edgar M. Sánchez Faba[1,2]; Yanet B. Mansilla[3,4]; Liliana V. Mogni[1,2]; Loreto Troncoso[3,4]

1. Departamento Caracterización de Materiales (DCM-CAB-CNEA); 2. Instituto de Nanociencia y Nanotecnología (UE-INN-Nodo Bariloche, CNEA-CONICET); 3. Instituto de Ingeniería Mecánica, Universidad Austral de Chile; 4. MIGA Millennium Institute

INTRODUCTION

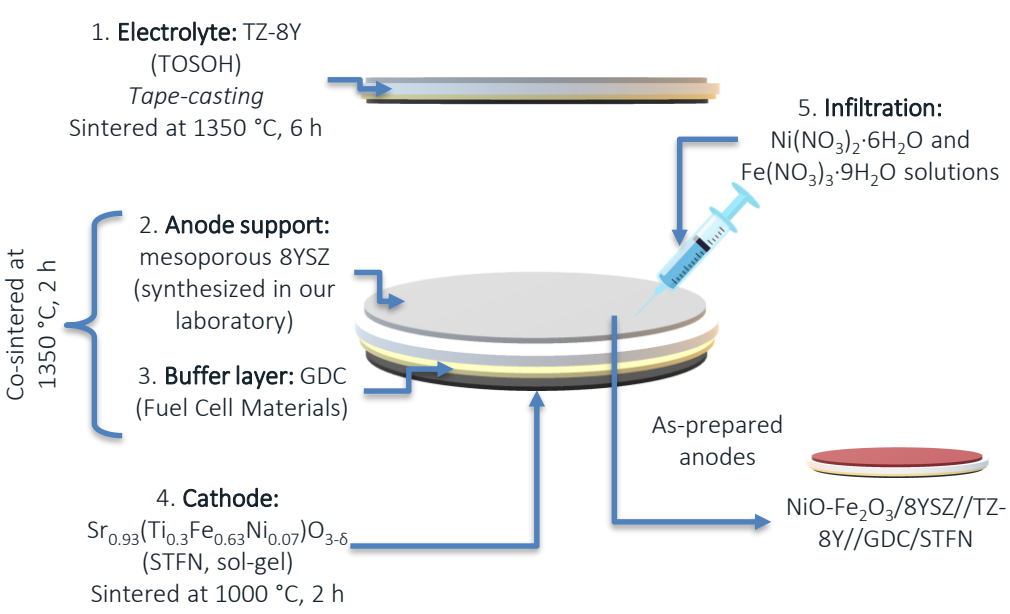
Ammonia is a promising fuel for *Solid Oxide Fuel Cells* due to its high energy density and its ability to be stored under moderate conditions. However, the main issues with direct ammonia-fed SOFCs are the *slow kinetics of NH_3 cracking and the poor stability of the Ni/YSZ anode, which undergoes nitriding*. For this reason, other active elements such as transition metals are often added to enhance the electrode efficiency.

OBJETIVE

This study explores the *modification of a Ni/8YSZ anode with iron for direct ammonia-fed SOFCs*. Fe could act synergistically with Ni, reducing the activation energy for NH_3 cracking and enhancing the cermet's stability.

METHODOLOGY: SOFC fabrication

The cell was fabricated using an approach that employs multiple techniques, including tape casting, screen printing, and infiltration.



Reduced anode composition : 30 wt% Ni, 10 wt% co-catalyst, and 60 wt% 8YSZ.

RESULTS AND DISCUSSION

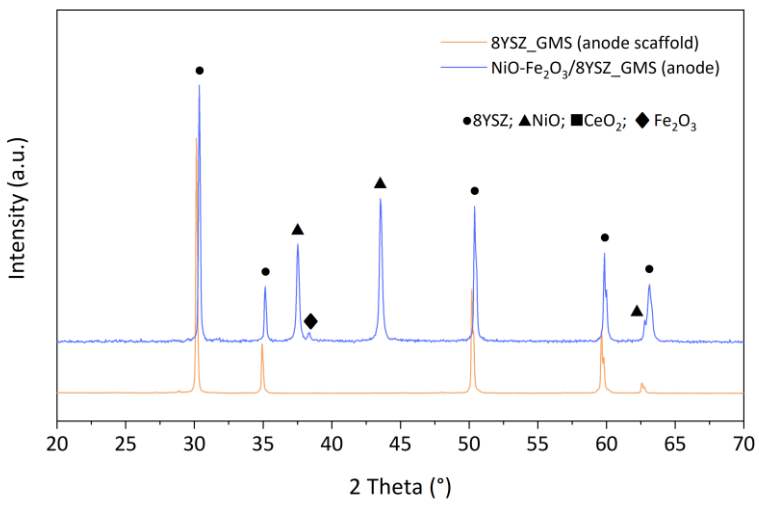


Figure 1. DRX patterns of the 8YSZ scaffold and the as-prepared anode.

Besides the characteristic reflections of *Fm-3m* cubic fluorite-type 8YSZ, crystalline NiO and a single low-intensity peak assigned to Fe_2O_3 were identified, which may indicate its incorporation into a $Ni_{1-x}Fe_xO$ solid solution.

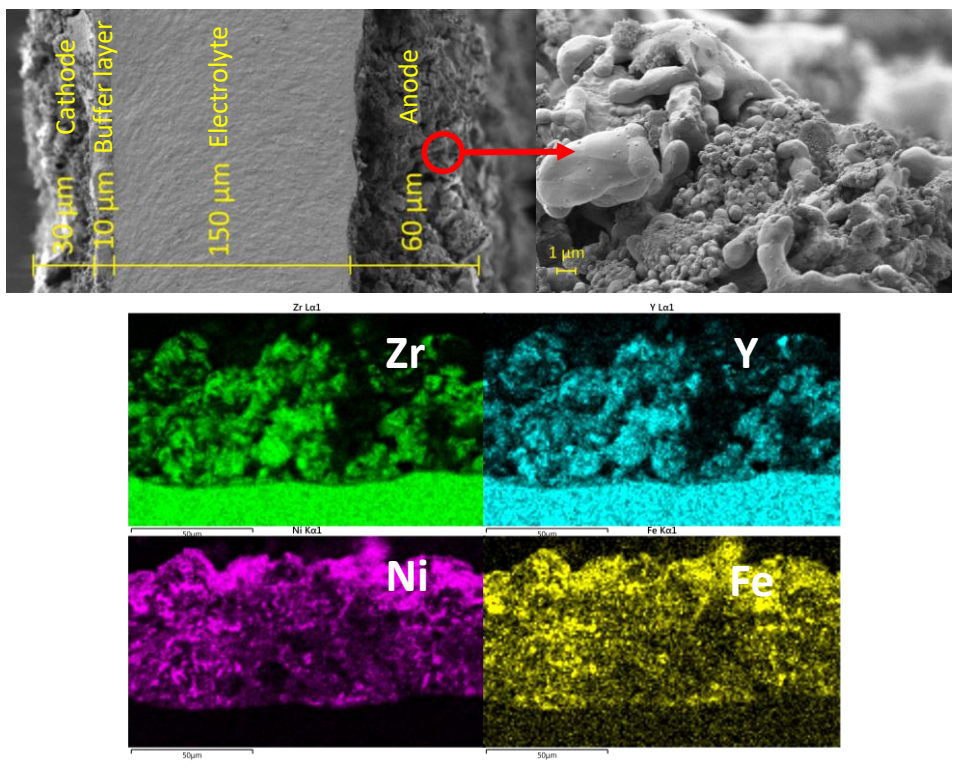


Figure 2. SEM image of the cell cross-section and EDS maps of the reduced anode (Zr, Y, Ni, and Fe).

The maximum power density delivered by the Fe-modified anode decreased from 96 mW cm^{-2} in H_2 to 49 mW cm^{-2} in NH_3. Then, the electrode appears to be less effective at coupling ammonia conversion and electrochemical oxidation.

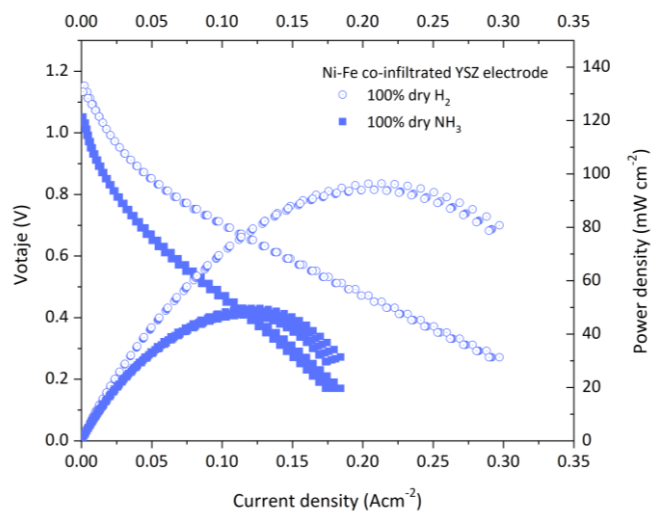


Figure 3. I-V-P curves in H_2 at 750 °C and a fuel flow rate of 120 mL min^{-1}.

After operation, Raman spectrum showed bands assigned to Ni–N bonds, indicating the formation of nickel nitride species–a phase that hinders the catalytic activity of Ni in the NH_3 decomposition and the oxidation of the in-situ generated H_2.

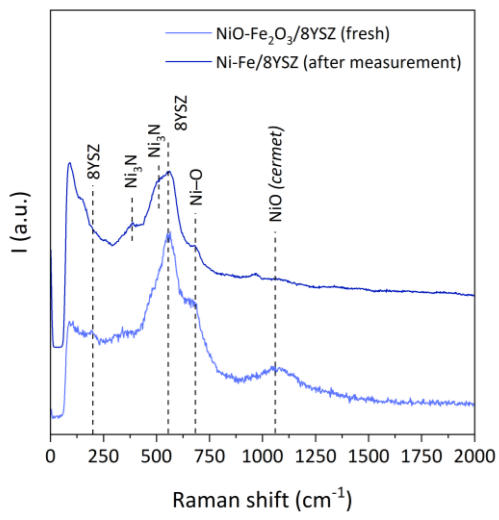


Figure 4. Raman spectra of the anode before and after electrochemical tests.

CONCLUSIONS:

A Fe-modified Ni/8YSZ anode was evaluated for direct NH_3 -fed SOFC operation. XRD confirmed the presence of NiO, and the incorporation of an Fe fraction as a solid solution. EDS analysis showed a homogeneous distribution of the infiltrated phases throughout the electrode. The cell showed a ~50% decrease in power density when switching the fuel. Raman spectroscopy revealed the formation of N-containing species compatible with Ni_3N, which may contribute to its poor performance under ammonia. Alternative Fe incorporation strategies should be explored to mitigate Ni nitridation. Particularly, sequential infiltration to form an Fe overlayer could promote NH_3 decomposition, improving the synergistic effect between both phases.