

## Supplementary Materials

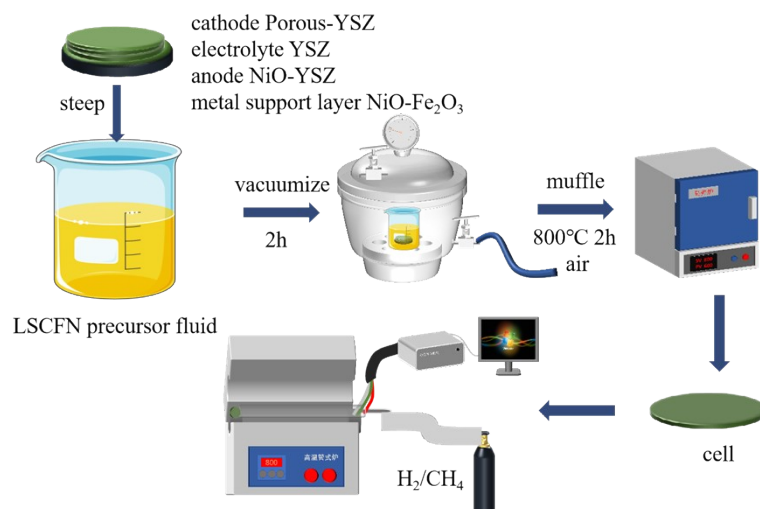


Fig. S1 Schematic diagram of the full cell impregnation of NiO-Fe<sub>2</sub>O<sub>3</sub>/NiO-YSZ/YSZ/P-YSZ and NiO-YSZ/YSZ/P-YSZ

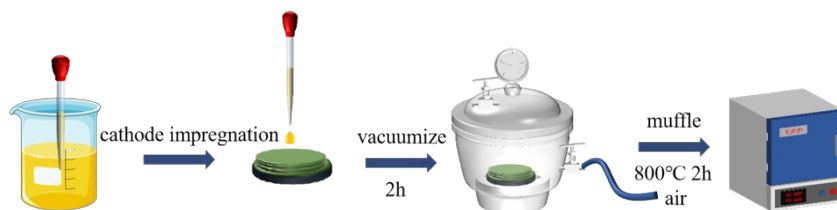


Fig. S2 Schematic diagram of the cathode impregnation of NiO-Fe<sub>2</sub>O<sub>3</sub>/NiO-YSZ/YSZ/P-YSZ and NiO-YSZ/YSZ/P-YSZ

Figure S3(a) shows the cross-sectional SEM image of the metal support, with the porosity measured using ImageJ software. 10 cross-sectional SEM images at 1000x magnification were analyzed to calculate the average porosity. The results indicate that the initial porosity is 34.3%. To validate the accuracy of the ImageJ porosity measurements, a Ni-Fe support sample was analyzed using a mercury porosimeter, yielding a porosity of 34.5%, demonstrating minimal error between the two methods. Figure S3(b) displays the SEM image of the support after 1000 h of corrosion in a H<sub>2</sub>/N<sub>2</sub>-25% H<sub>2</sub>O atmosphere, with the porosity reduced to 33.5%. Figures S3(c-h) present the SEM images and corresponding EDS of the cross-sections of the fully impregnated cell, including the anode, support, and cathode. Due to the low

concentration of Nb in the perovskite and its limited surface presence, Nb was not detected in the EDS images.

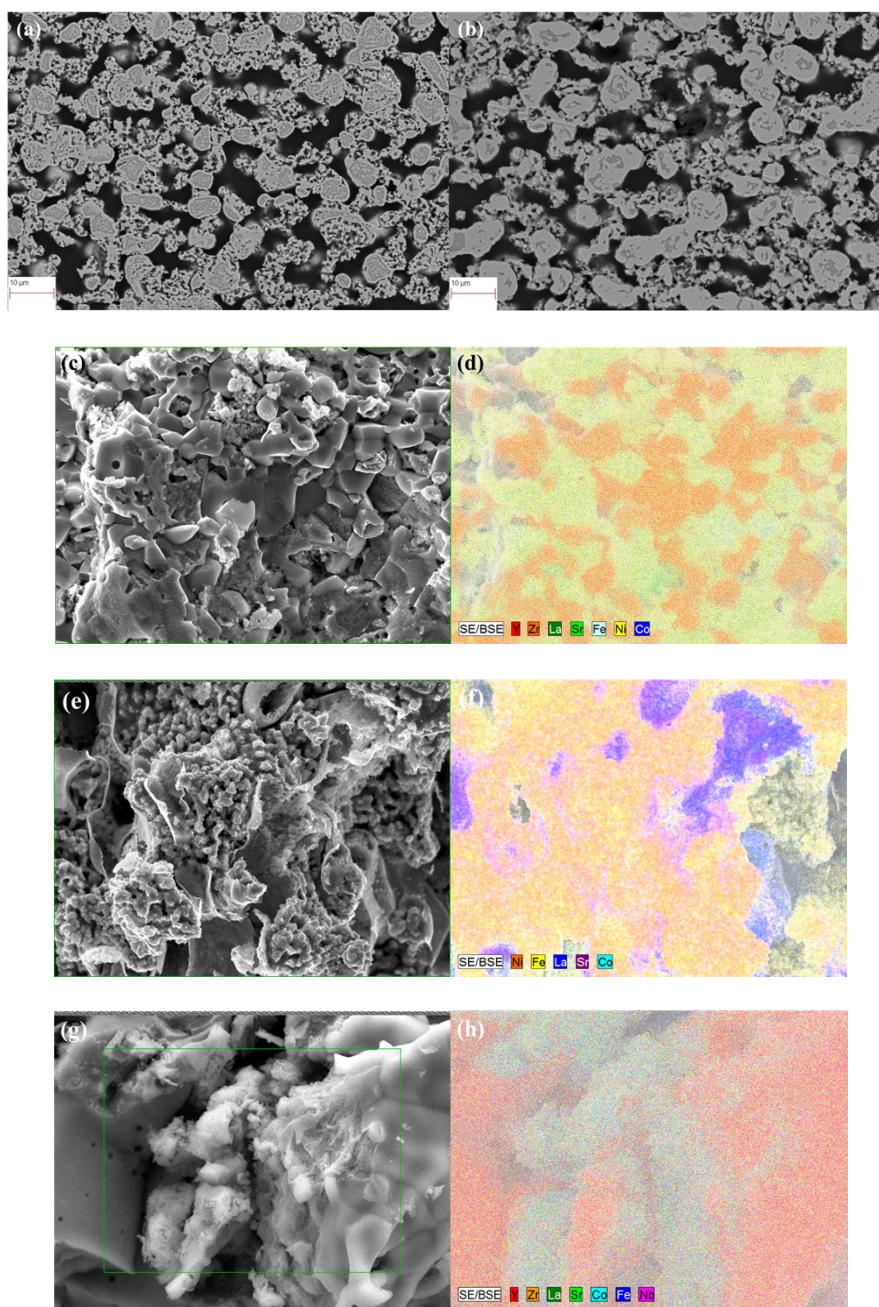


Fig. S3 SEM cross-sectional images of the porous Ni-Fe support (a) and after 1000 h of exposure in a  $H_2/N_2$ -25%  $H_2O$  atmosphere (b), cross-section of the anode layer after full impregnation (c) with corresponding EDS (d), metal support layer after full impregnation (e) with corresponding EDS (f), and cathode layer (g) with corresponding EDS (h)