

Boosting Solid Oxide Fuel Cell Performance Via Electrolyte Thickness Reduction and Cathode Infiltration

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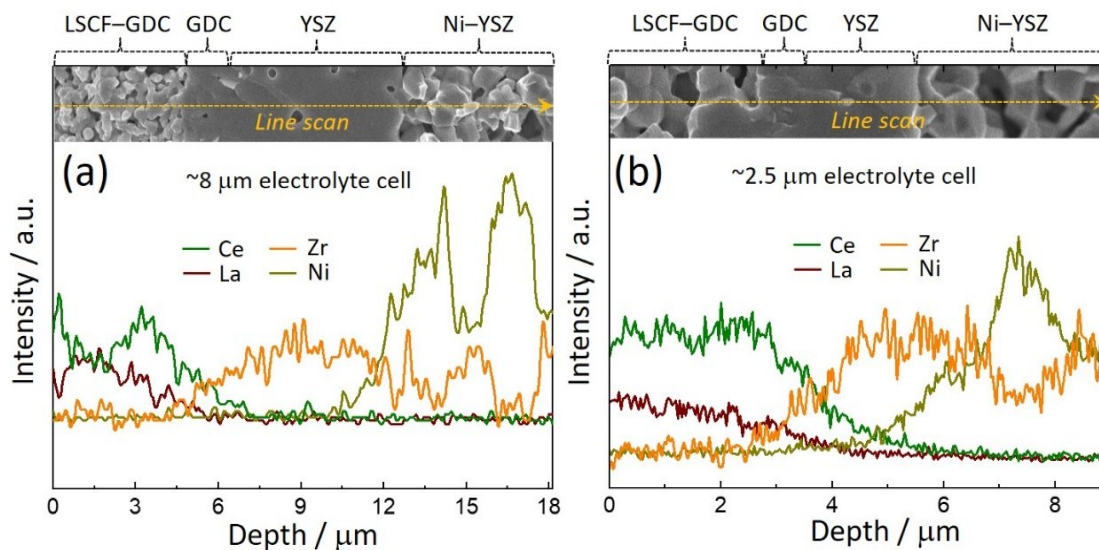


Fig. S1 SEM-EDS line-scan concentration profiles for the representative elements Ce, Zr, La, and Ni across the t8 and t2.5 cells.

Fig. S1 shows SEM-EDS line scans across the electrolyte and electrode functional regions of the cells with 8 (a) and 2.5 μm (b) thick electrolytes. Note that the PrO_x -infiltrated cell is identical to that in (b) and hence is not shown; the Pr amount in the infiltrated cathodes was too small to detect by EDS. The anode shows the expected Ni and Zr signals, whereas the cathode shows the expected La and Ce intensity. From the Ce and Zr intensity distributions in the electrolyte, the GDC layer thickness is estimated to be ~1 μm in both cases, such that the YSZ thickness is estimated to be ~7 μm in the t8 cell and ~1.5 μm in the t2.5 cell. While much of the interface broadening evident in Fig. S1 is due to the spatial resolution of SEM-EDS (~1 μm), prior results suggest that there is also limited YSZ/GDC interface broadening (~0.5 μm) resulting from the 1250 °C co-firing of these two layers, low enough to minimize the electrolyte resistance contribution from the low-conductivity intermixed layer.

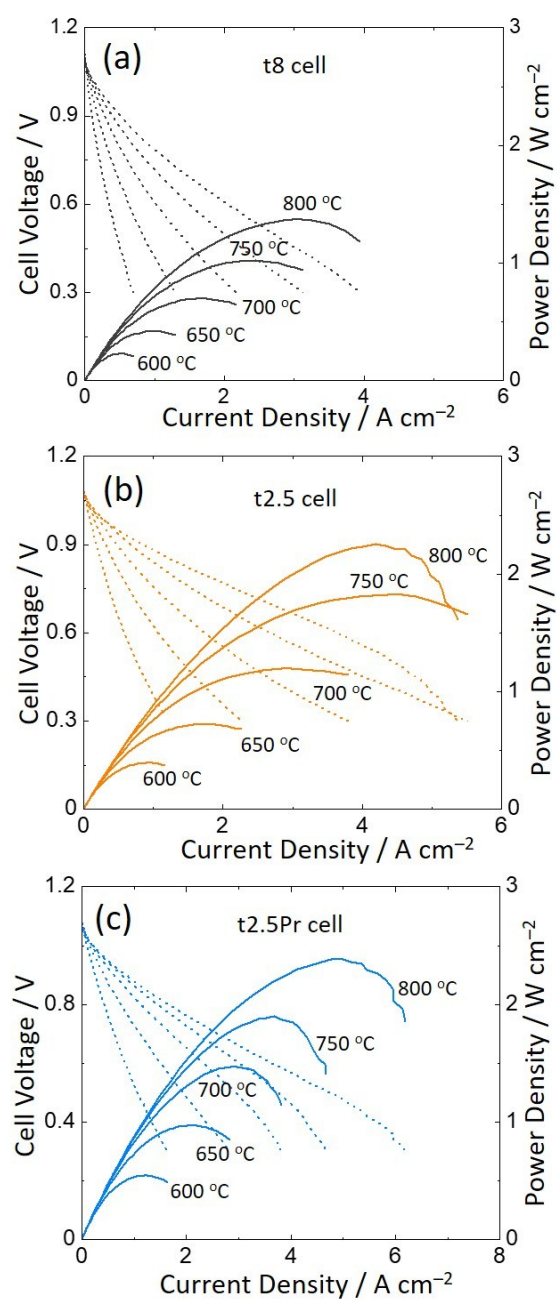


Fig. S2 Voltage and power density versus current density for the t8, t2.5, and t2.5Pr cells measured at 800–600 °C in 3 vol.% H₂O-humidified H₂ and air.

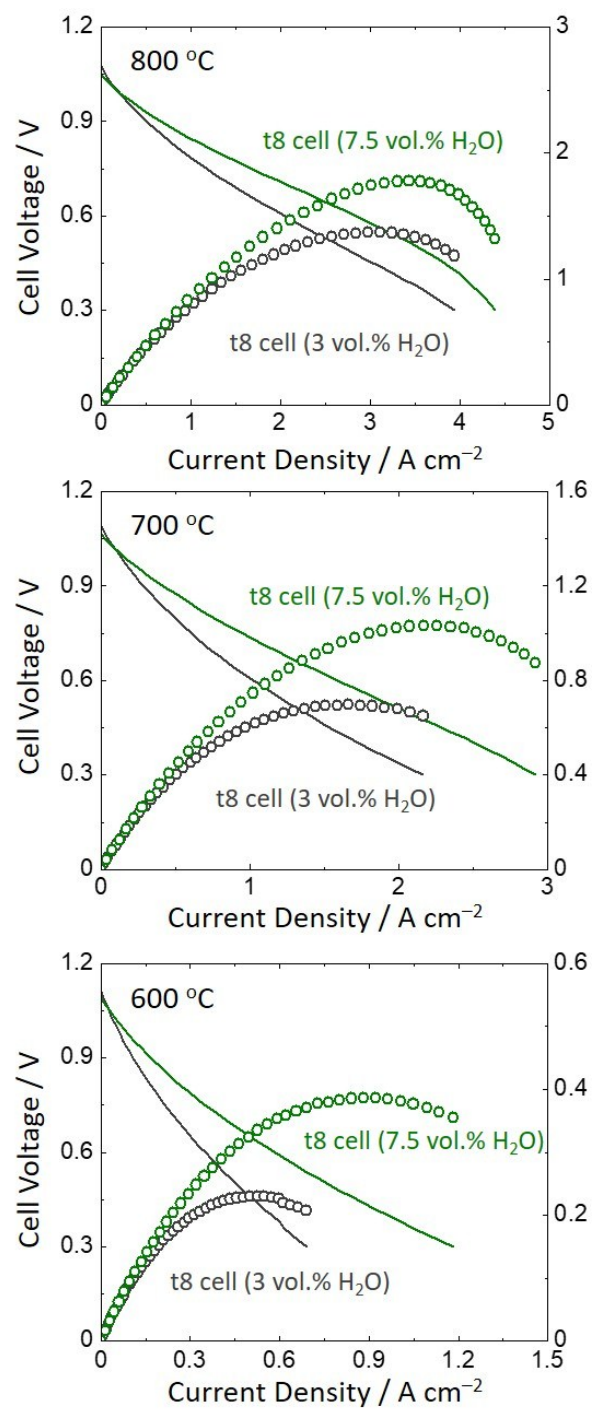


Fig. S3 Comparison of voltage and power density versus current density at 600, 700, and 800 °C for the t8 cells (3 and 7.5 vol.% H₂O) and the t2.5 cell (3 vol.% H₂O).

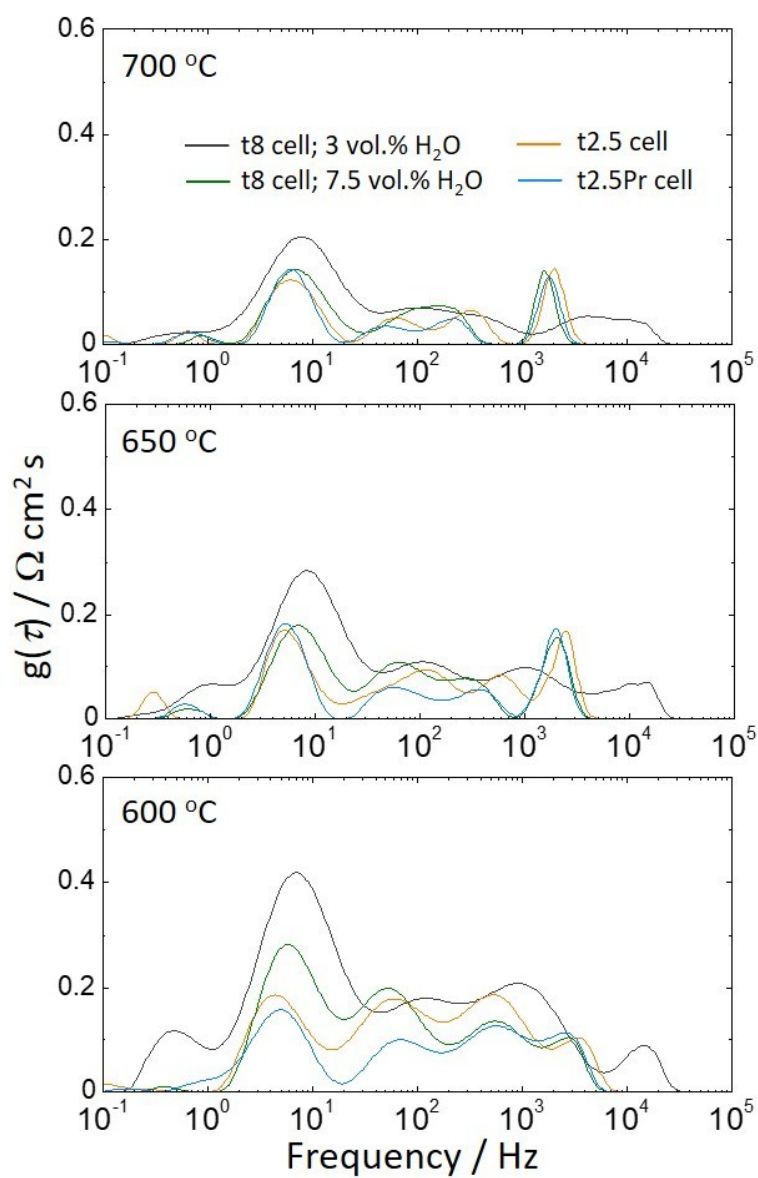


Fig. S4 Distribution of relaxation times (DRT) of the EIS spectra obtained from the t8 cells measured in 3 or 7.5 vol.% H₂O-humidified H₂ and air and the t2.5 and t2.5Pr cells measured in 3 vol.% H₂O-humidified H₂ and air.

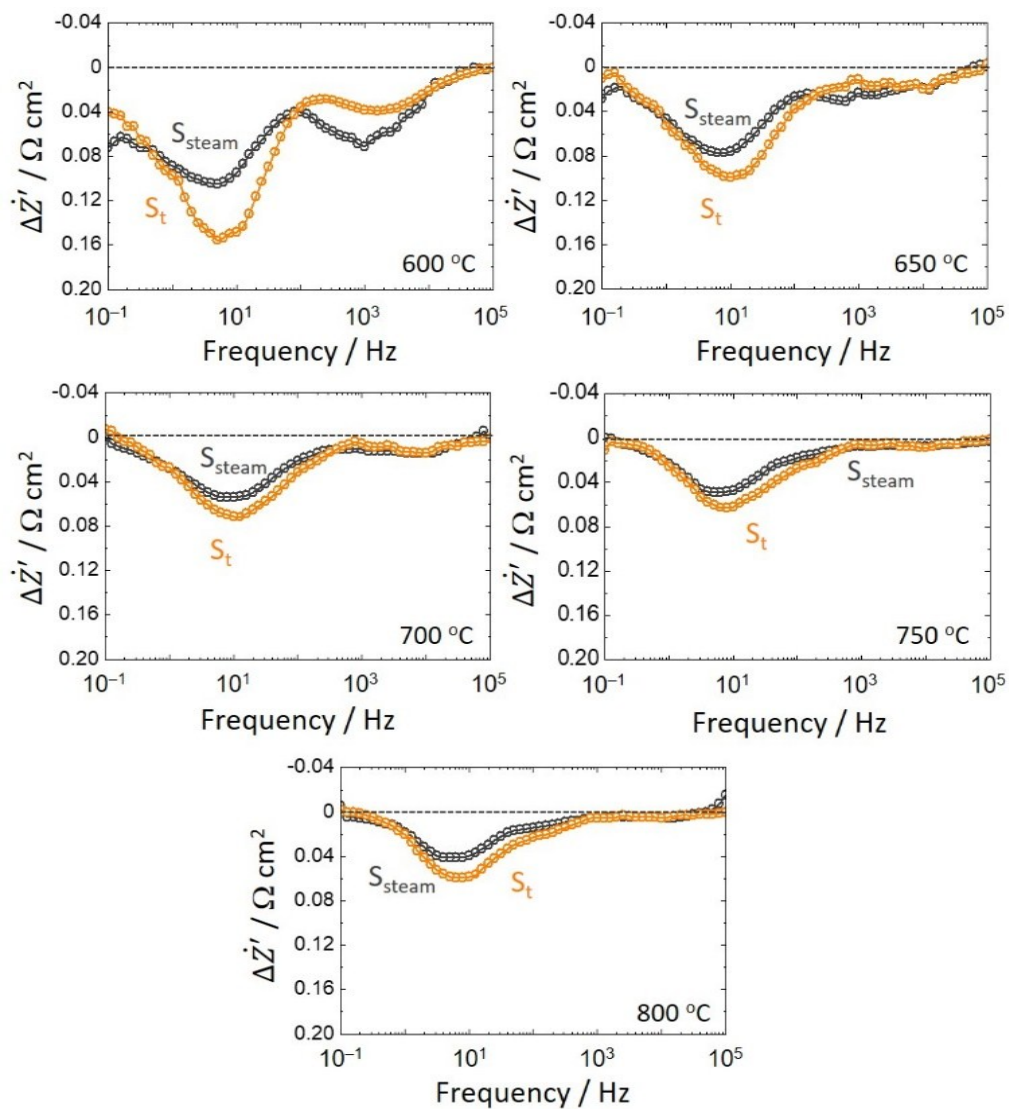


Fig. S5 $\Delta Z'$ spectra obtained from the EIS data of cell baseline showing the changes caused by increasing the steam content to 7.5 vol.% (S_{steam}) and reducing the electrolyte thickness to $\sim 2.5 \mu\text{m}$ (S_t). Spectra S_{steam} (or S_t) was obtained by subtraction of the baseline cell using 3 vol.% H_2O from the baseline cell using 7.5 vol.% H_2O (or the t2.5 cell).

This section provides some background on how to calculate the effective fuel steam content required for the given OCVs in Fig.4,

The additional steam contents generated by the gas leakage for the t8 and the t2.5 cells in 3 vol.% H₂O–97 vol.% H₂ and air are estimated to be ~3.5 and ~8 %, respectively, by using the following equation:

$$E = E_0 - \frac{RT}{2F} \left[\frac{(0.03 + P_s)}{(0.97 - P_s)0.21^{0.5}} \right]$$

where E_0 is the reversible potential, P_s is the effective steam content, and R, F, and T have their usual meanings.