Supporting Information for

Gas leak diffusion induced polarization in submicro/nanoscale non-tight electrolytes of solid oxide fuel cells

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![Graph](image1.png)

Fig. S1 Area-specific residence (ASR) of YSZ electrolyte as a function of temperature. The ionic conductivity of YSZ is adopted from Ref. [1]. The data for YSZ electrolyte with a thickness of 100 μm, 10 μm, 1 μm, 100 nm and 10 nm are given. To ensure ASR < 0.15 Ω cm², as indicated by the dash line, an operating temperature > 900 °C, > 660 °C, > 490 °C and > 370 °C is required for YSZ of 100 μm, 10 μm, 1 μm and 10 nm thicknesses, respectively.

![Graph](image2.png)

Fig. S2 ASR as a function of YSZ thickness in the range of (a) 0~1000 nm and (b) 0~100 μm, at different
temperatures. To ensure ASR < 0.15 \(\Omega\cdot\text{cm}^2\) and \(\mu\text{SOFCs}\) operate below 400 °C, the thickness of YSZ should be decreased to < 200 nm.

**Fig. S3** Electrolyte leak gas diffusion induced cathode concentration polarization as a function of temperature when the electrolyte thickness is (a-b) 100 nm and (c-d) 10 \(\mu\text{m}\), respectively. (a) and (c) show \(\eta^l\) versus \(T\). (b) and (d) show the proportion of \(\eta^l\) to the total cathode polarization versus \(T\). In the calculations, SOFCs operate at an output current density of 0.1 A/cm\(^2\). It is assumed that the leaked H\(_2\) and O\(_2\) do not react directly (\(x = 0\)).
Fig. S4 Electrolyte leak gas diffusion induced cathode concentration polarization as a function of temperature when the electrolyte thickness is (a-b) 100 nm and (c-d) 10 μm, respectively. (a) and (c) show the $\eta_c^I$ versus $T$. (b) and (d) show the proportion of $\eta_c^I$ to the total cathode polarization versus $T$. In the calculations, SOFCs operate at an output current density of 0.1 A/cm$^2$. It is assumed that the leaked H$_2$ and O$_2$ react completely ($x = 1$).
Fig. S5 Electrolyte leak gas diffusion induced anode concentration polarization as a function of temperature when the electrolyte thickness is (a-b) 100 nm and (c-d) 10 μm, respectively. (a) and (c) show the $\eta_a$ versus $T$. (b) and (d) show the proportion of $\eta_a$ to the total cathode polarization versus $T$. In the calculations, SOFCs operate at an output current density of 0.1 A/cm². It is assumed that the leaked H₂ and O₂ react completely ($x = 1$).

References