

A Solid Oxide Cell Yielding High Power Density Below 600°C

Zhongliang Zhan,^{*a} Da Han,^a Tianzhi Wu,^a Xiaofeng Ye,^a Shaorong Wang,^a Tinglian Wen,^a Sungmee Cho^b and Scott A Barnett^b

^a *CAS Key Laboratory of Materials for Energy Conversion, Shanghai Institute of Ceramics, Chinese Academy of Sciences (SICCAS), 1295 Dingxi Road, Shanghai 200050, P. R. China.
Fax: 86-21-6998-7669; Tel: 86-21-6998-7669; E-mail: zzhan@mail.sic.ac.cn*

^b *Department of Materials Science and Engineering, Northwestern University, 2220 Campus Drive, Evanston IL, 60208 USA*

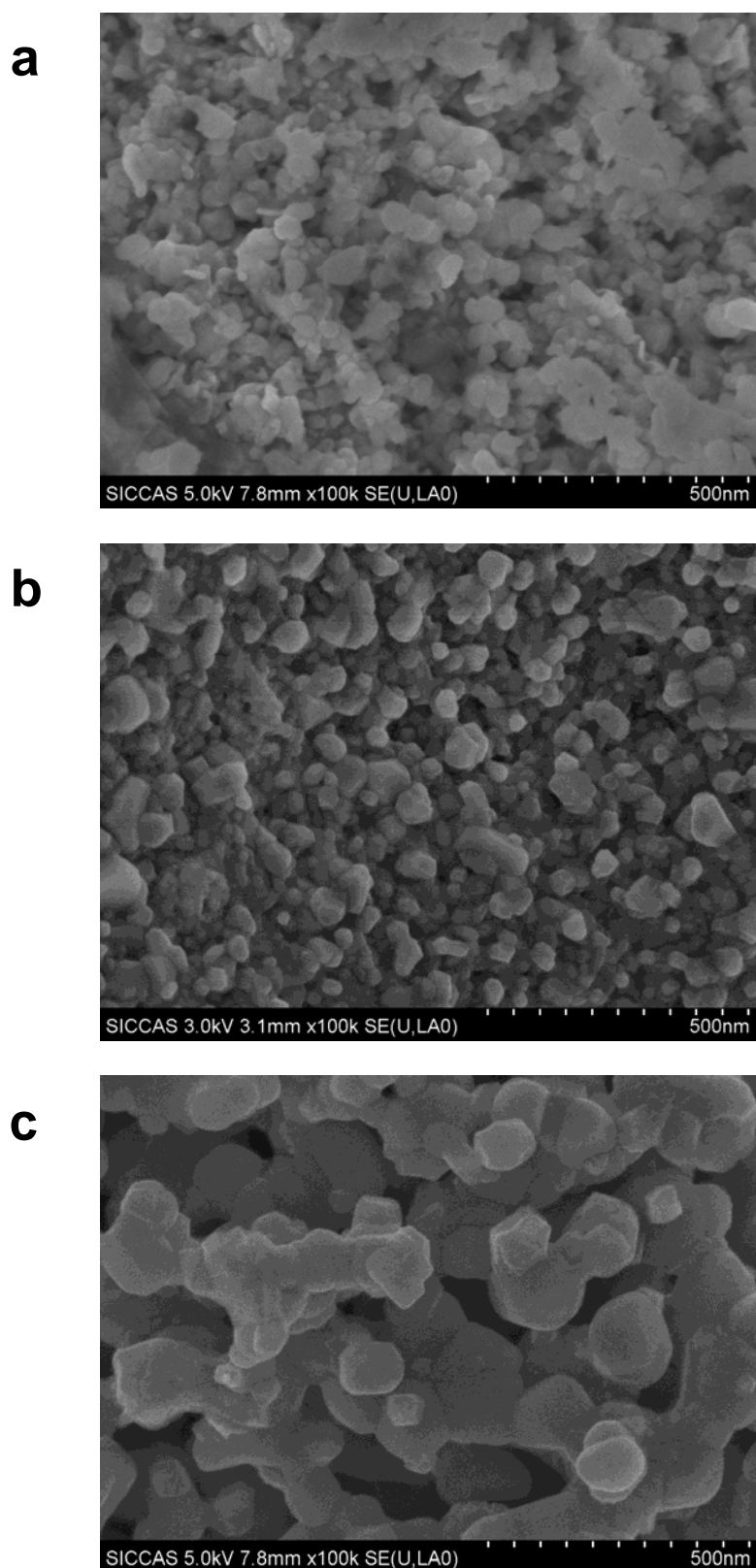


Fig. S1 SEM images showing the nanoporous electrode coatings: (a) Ni anodes at $V = 7.2\%$, (b) SSC-SDC cathodes at $V = 12.9\%$, and (c) SSC cathodes at $V = 12.9\%$.

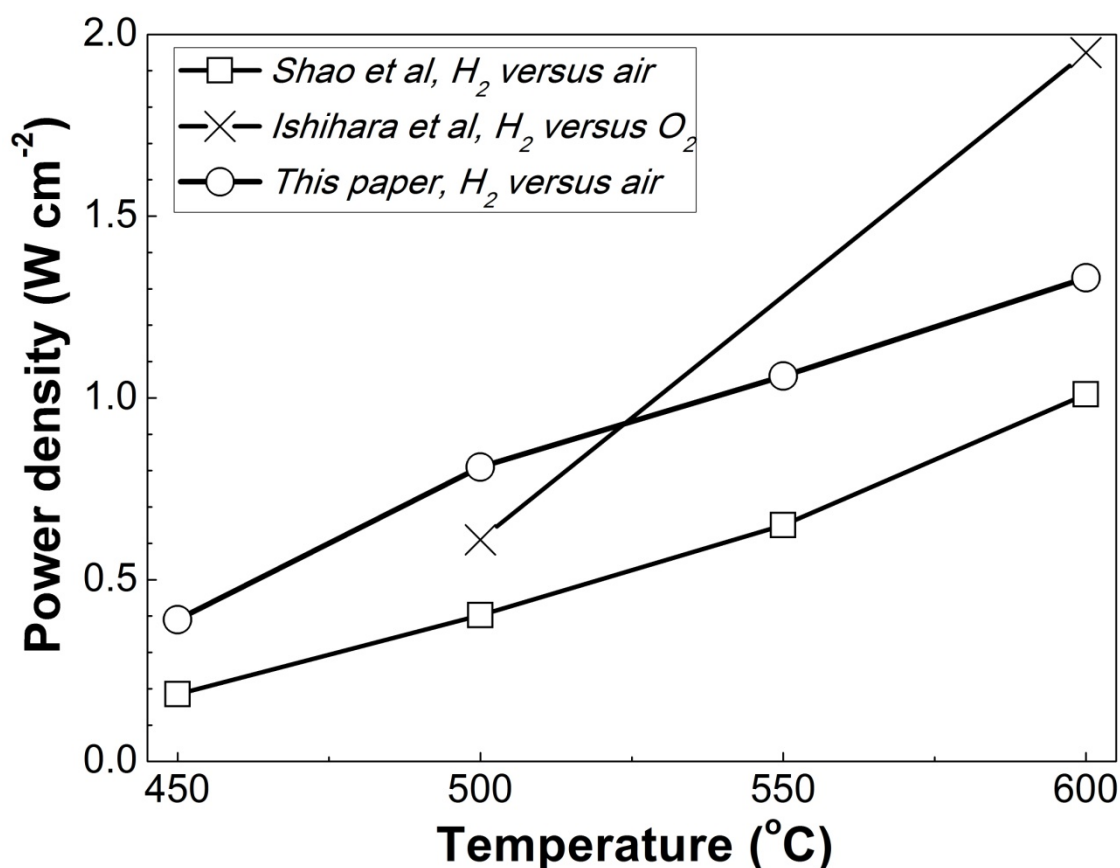


Fig. S2 Maximum power densities as a function of temperature for different low-temperature fuel cells. Under similar operating conditions, the present thin LSGM electrolyte fuel cells yielded much higher power densities than thin Sm-doped Ceria (SDC) electrolyte fuel cells reported by Shao *et al*¹, which can be ascribed to higher catalytic activities of the present dual-scale cathode structure that yields lower R_p , *e.g.*, $0.075 \Omega \text{ cm}^2$ for the present SSC-SDC cathodes versus $0.2 \Omega \text{ cm}^2$ for (Ba,Sr)(Co,Fe)O₃ cathodes at 550°C ¹. Note that these SDC electrolyte cells also yielded relatively low open-circuit potentials. The present cells yielded higher power density than the pulsed laser deposited LSGM/SDC bi-layer electrolyte cells reported by Yan *et al*, except at 600°C ^{2,3}. However, their high power density resulted from the use of oxygen as the oxidant, which invariably enhances cathode performance, compared to air; when the present cells were tested with oxygen, a comparable maximum power density of 1.85 W cm^{-2} at 600°C was achieved.

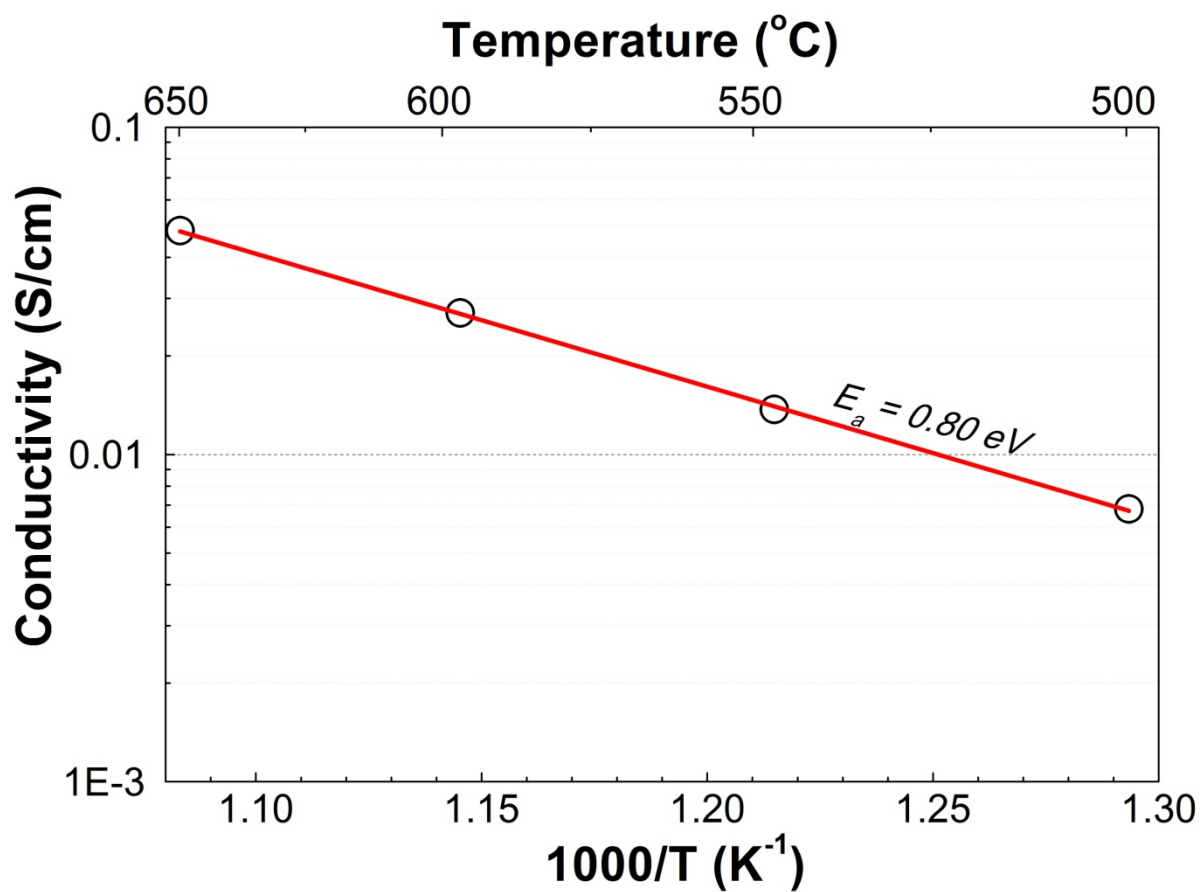


Fig. S3 Conductivity of a bulk LSGM electrolyte versus inverse temperature. The activation energy for the oxide ion conduction was estimated to be 0.80 eV.

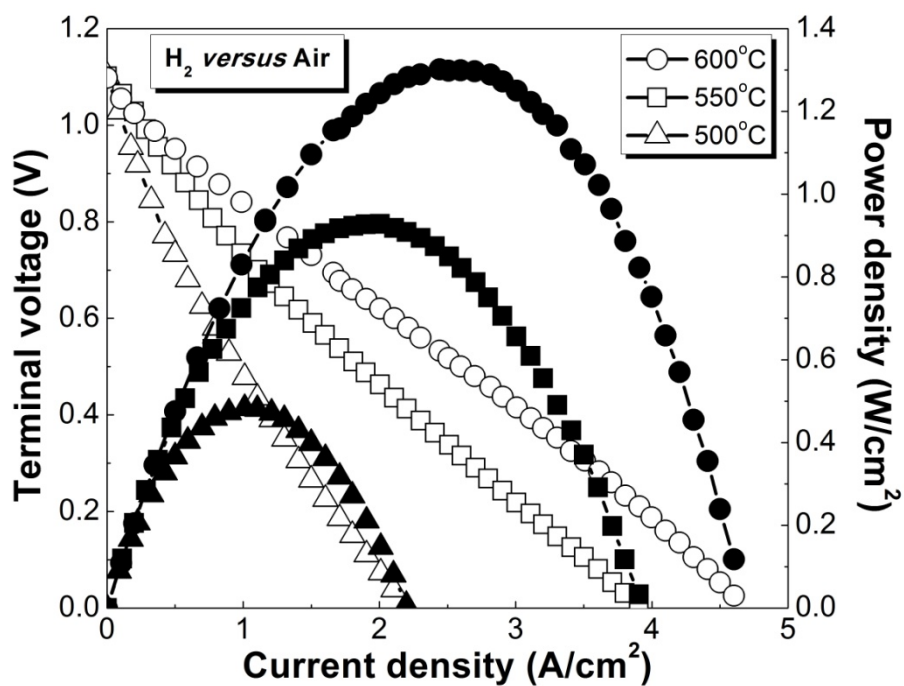


Fig. S4 Current-voltage characteristics of a thin LSGM electrolyte fuel cell with $V_{Ni} = 7.2\%$ and $V_{SSC} = 12.9\%$, operated on humidified hydrogen and ambient air at 500-600°C.

References

- 1 Shao, Z. P. & Haile, S. M. A high-performance cathode for the next generation of solid-oxide fuel cells. *Nature* **431**, 170-173 (2004).
- 2 Yan, J., Matsumoto, H., Akbay, T., Yamada, T. & Ishihara, T. Preparation of LaGaO₃-based perovskite oxide film by a pulsed-laser ablation method and application as a solid oxide fuel cell electrolyte. *Journal of Power Sources* **157**, 714-719 (2006).
- 3 Yan, J. W., Matsumoto, H., Enoki, M. & Ishihara, T. High-power SOFC using La_{0.9}Sr_{0.1}Ga_{0.8}Mg_{0.2}O_{3-δ}/Ce_{0.8}Sm_{0.2}O_{2-δ} composite film. *Electrochem Solid St* **8**, A389-A391 (2005).