

## Electronic supplementary information

### High performance nanostructured bismuth oxide-cobaltite as a durable oxygen electrode of reversible solid oxide cells

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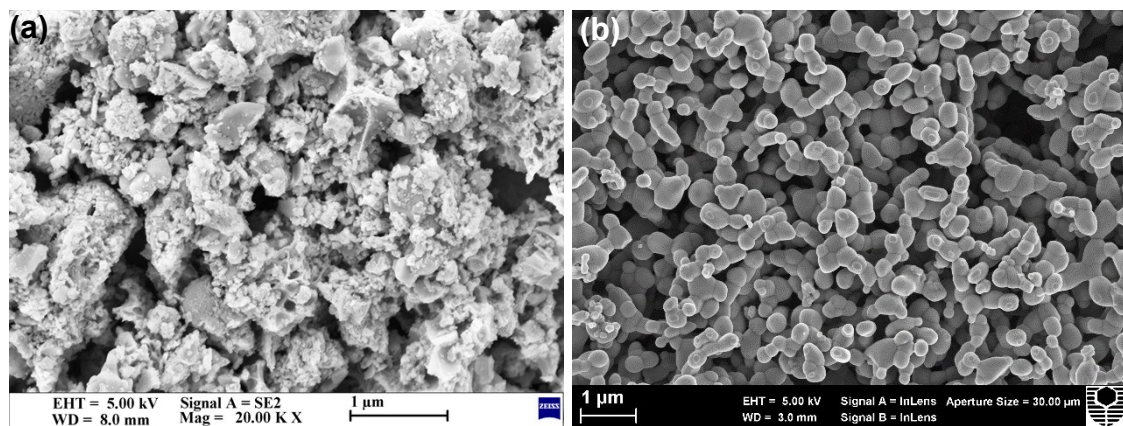
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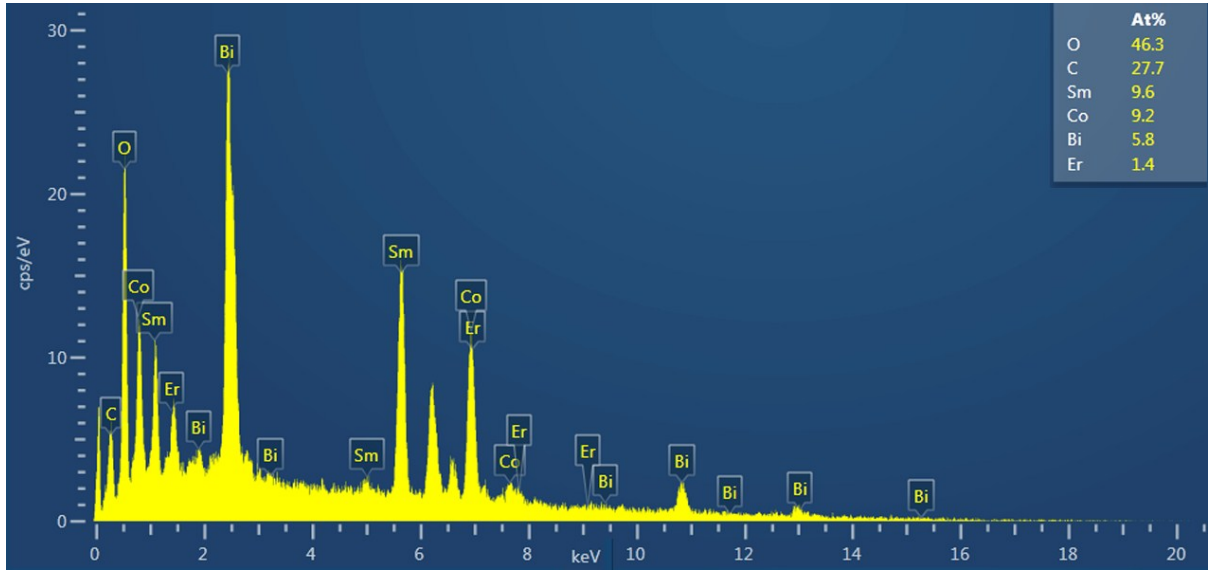
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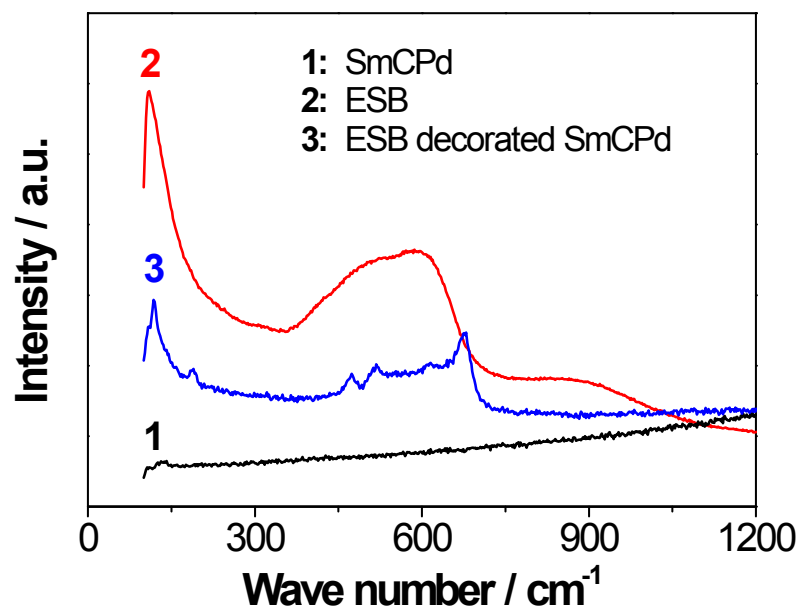
<sup>‡</sup>These authors contributed equally.



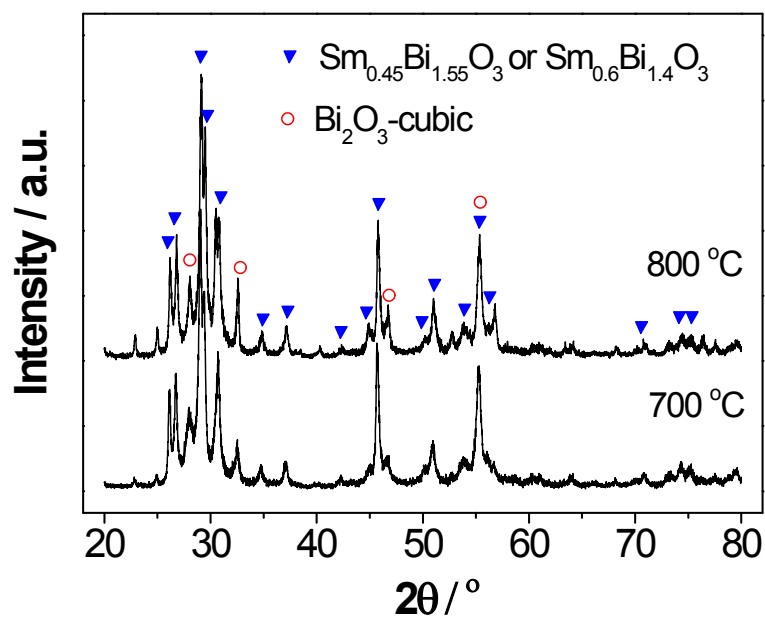
**Fig. S1** SEM micrographs of surface of directly assembled (a) decorated ESB-SmCPd composite electrode and (b) pristine SmCPd electrode.



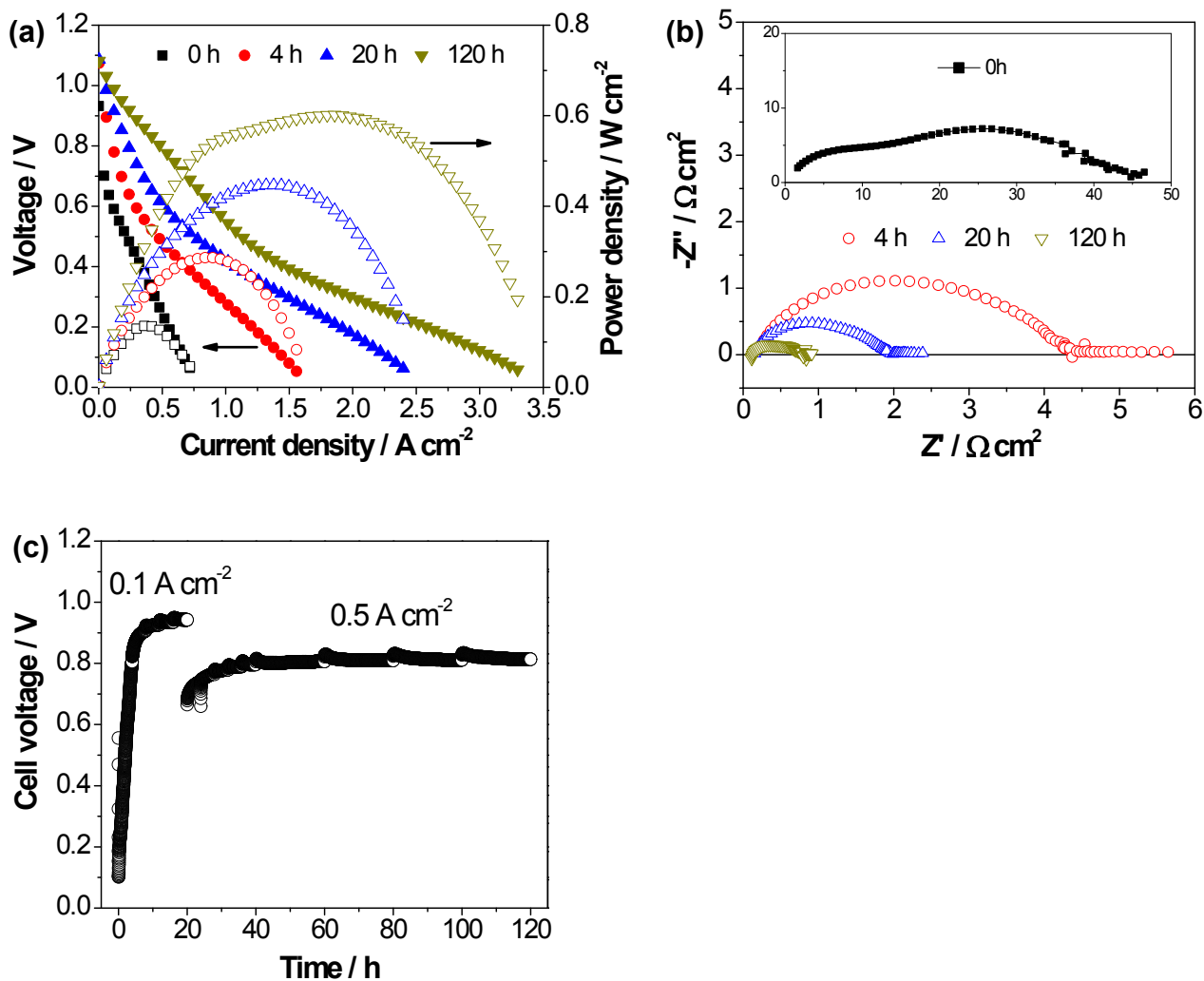
**Fig. S2** EDS spectra derived from surface of ESB decorated SmCPd electrode.



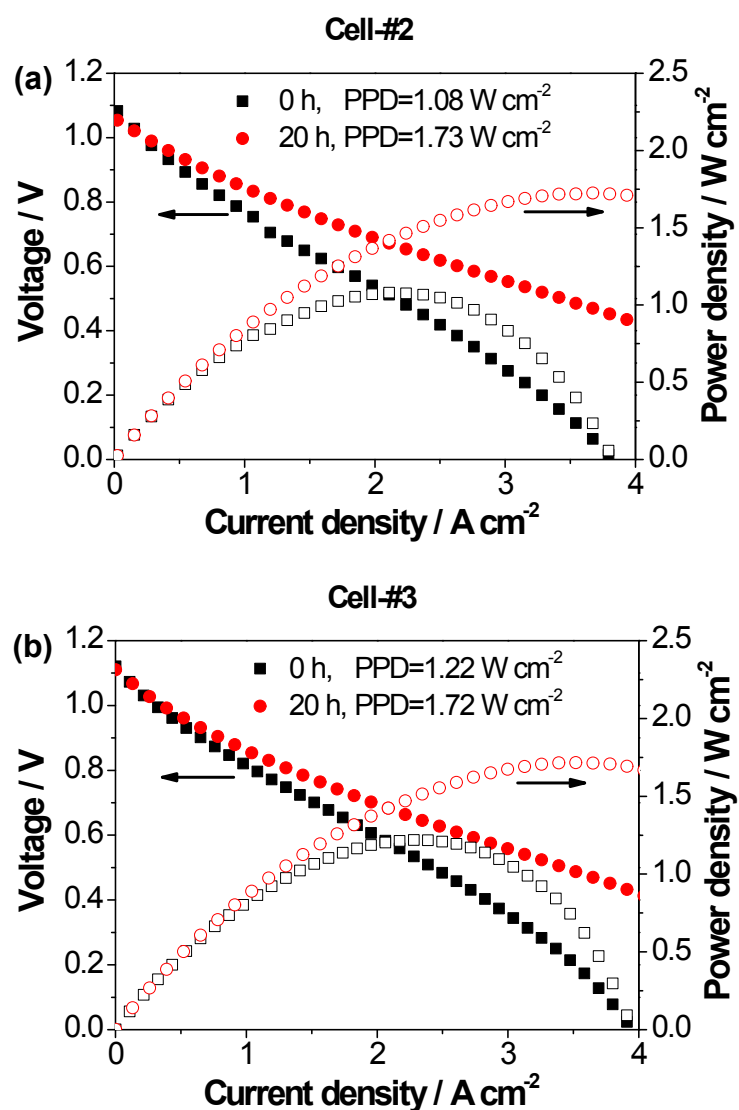
**Fig. S3** Raman spectra of SmCPd powder, ESB powder, and ESB decorated SmCPd composite powder calcined at 750 °C. A 532 nm laser in conjunction with a Renishaw Invia Raman microscope with a 50x objective was used.



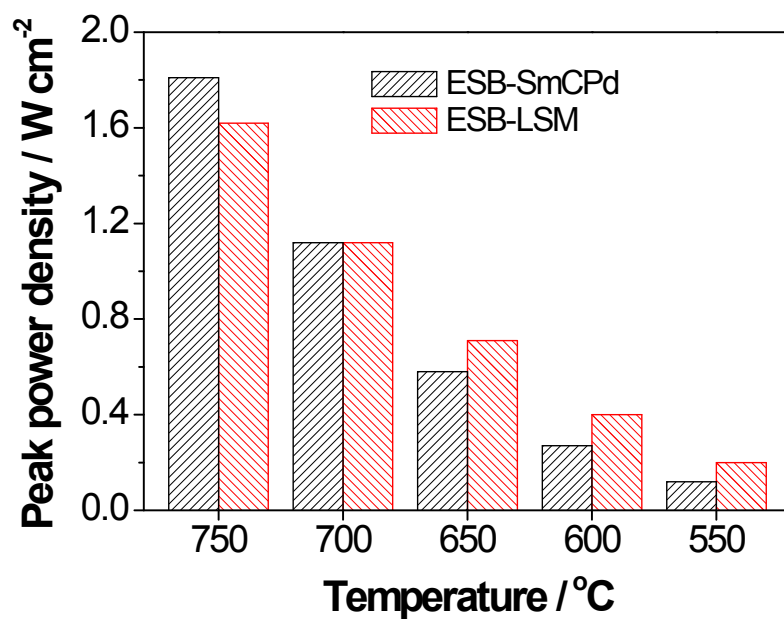
**Fig. S4** XRD patterns of  $\text{Bi}_2\text{SmO}_4$  to be synthesized, after being calcined at 700 and 800 °C for 3 h.



**Fig. S5** Polarization performance of a cell with directly assembled pristine SmCPd oxygen electrode as a function of polarization time at 750 °C at 0.1 A cm<sup>-2</sup> for 20 h and 0.5 A cm<sup>-2</sup> for 100 h in fuel cell mode,: (a) polarization curves, (b) impedance spectra, and (c) stability curve.

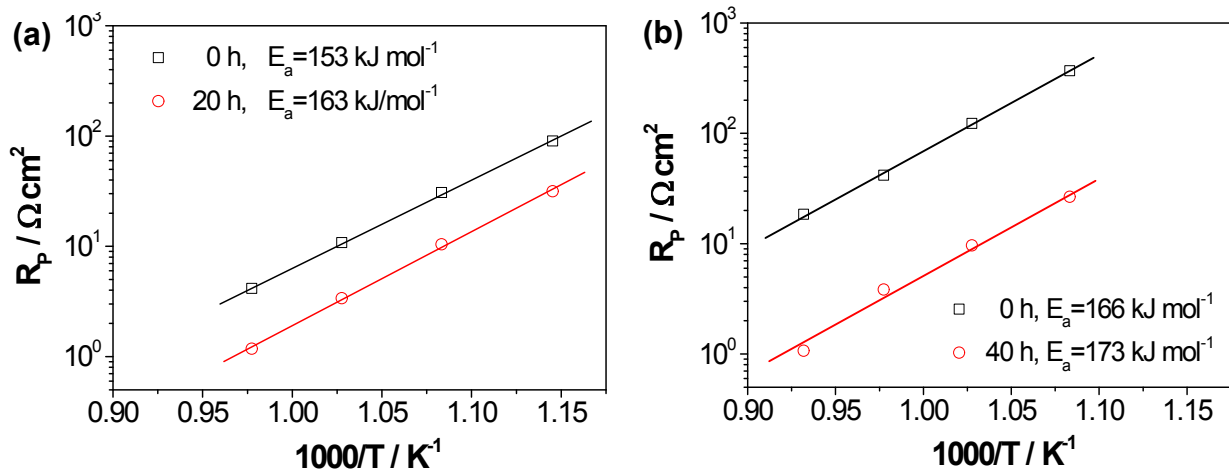


**Fig. S6** Polarization curves of two identical cells with directly assembled, decorated ESB-SmCPd oxygen electrodes as a function of polarization time at  $0.5 \text{ A cm}^{-2}$  and  $750 \text{ }^\circ\text{C}$  in fuel cell mode for 20 h: (a) Cell-#2 and (b) Cell-#3.

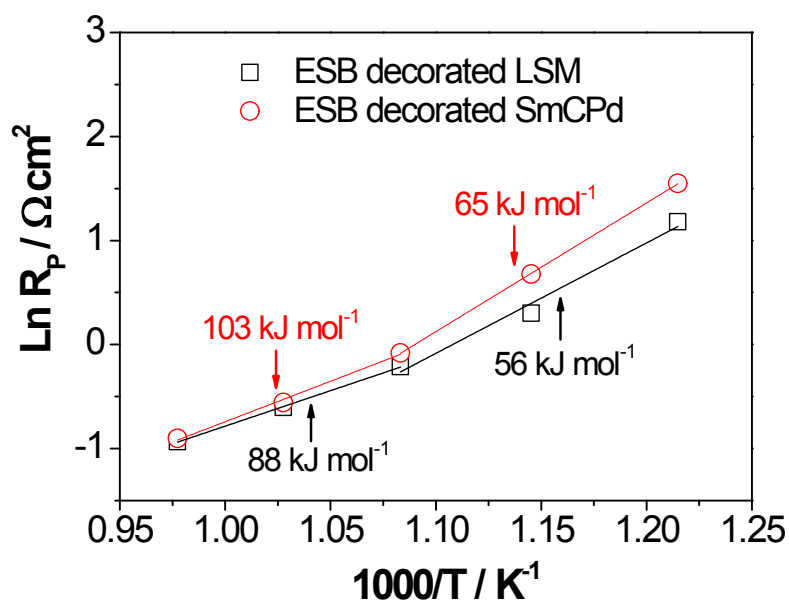


**Fig. S7** Comparison of peak power densities of the cells with directly assembled decorated 40%ESB-SmCPd and decorated 40%ESB-LSM<sup>1</sup> electrodes as a function of temperature.





**Fig. S8** Activation energy plots of half cells with directly assembled pristine (a) SmCPd and (b) LSM<sup>2</sup> oxygen electrodes on GDC electrolytes as a function of cathodic polarization time at 0.5 A cm<sup>-2</sup> and 750 °C.  $R_p$  values were derived from the impedance spectra measured at different temperatures (800-600 °C).



**Fig. S9** Activation energy plots of single cells with directly assembled 40 wt% ESB decorated SmCPd and 40 wt% ESB decorated LSM oxygen electrodes.  $R_p$  values were derived from the impedance spectra measured at different temperatures (750-550 °C). Prior to the tests, the cells were polarized at 0.5 A  $\text{cm}^{-2}$  and 750 °C for 20 h in fuel cell mode.

## References

1. N. Ai, N. Li, S. He, Y. Cheng, M. Saunders, K. Chen, T. Zhang and S. P. Jiang, *Journal of Materials Chemistry A*, 2017, 5, 12149 - 12157.
2. N. Li, N. Ai, K. Chen, Y. Cheng, S. He, M. Saunders, A. Dodd, A. Suvorova and S. P. Jiang, *RSC Advances*, 2016, 6, 99211-99219.