Electronic Supplementary Information (ESI)

Robust nano-architectured composite thin films for a low-temperature solid oxide fuel cell cathode

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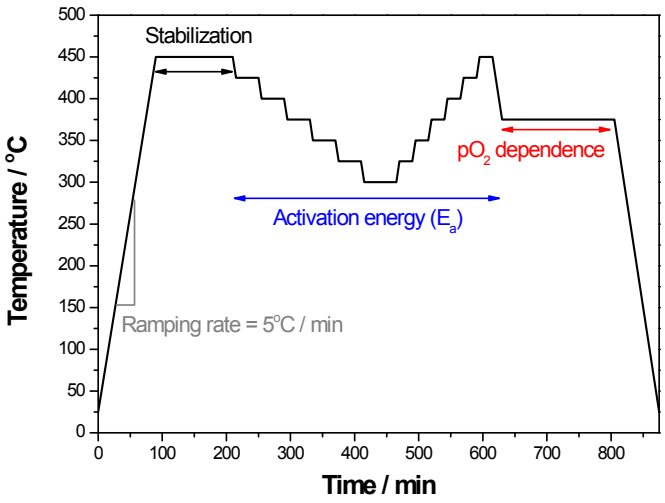

Fig. S1 Temperature profile for ACIS measurements as a function of time.

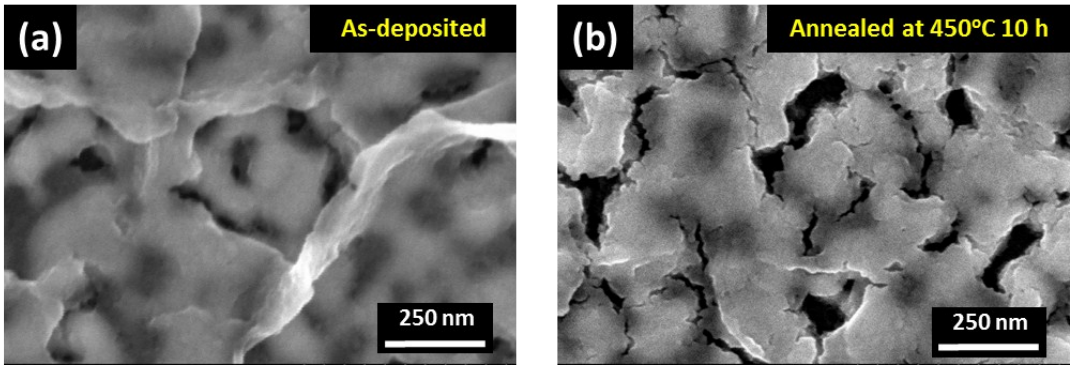

Fig. S2 Top-view SEM images of (a) as-deposited and (b) annealed composite films. Annealing at 450°C in air for 10 h.

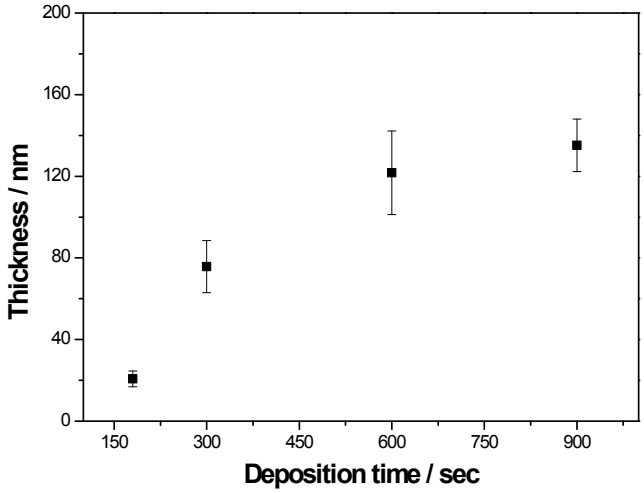

Fig. S3 SDC film thickness vs. CELD deposition time.

Experimental

1. Fabrication of dense $Sm_{0.2}Ce_{0.8}O_{1.9-\delta}$ interlayer

A dense interlayer of $Sm_{0.2}Ce_{0.8}O_{1.9-\delta}$ with a thickness of 200 nm were prepared via pulsed laser deposition (PLD) from a oxide target of the same composition on both (100) single-crystal YSZ substrate ($10 \times 10 \times 0.5$ mm^3). A Coherent COMPex Pro 205 KrF excimer laser, emitting at a wavelength of 248 nm, was used for ablation with the deposition parameters of a pulsed laser energy of 300 mJ and a laser repetition rate of 5 Hz. The deposition temperature and atmosphere were kept at 700°C and 7.5 mTorr O_2, respectively. For a more detailed description of fabrication and physical characterization process of SDC interlayer, the reader is referred to a publication by the authors.[1]

2. Physical Characterization of dense $Sm_{0.2}Ce_{0.8}O_{1.9-\delta}$ interlayer

For the out-of-plane reflections, high-resolution X-ray diffraction (HR-XRD) measurements were taken using a diffractometer (X'Pert-PRO MRD, PANalytical) operated at 45 kV and 40 mA with a fixed Cu anode.

The XRD result of epitaxial SDC interlayer grown onto a (100) single-crystal YSZ substrate are shown in Fig. S4.

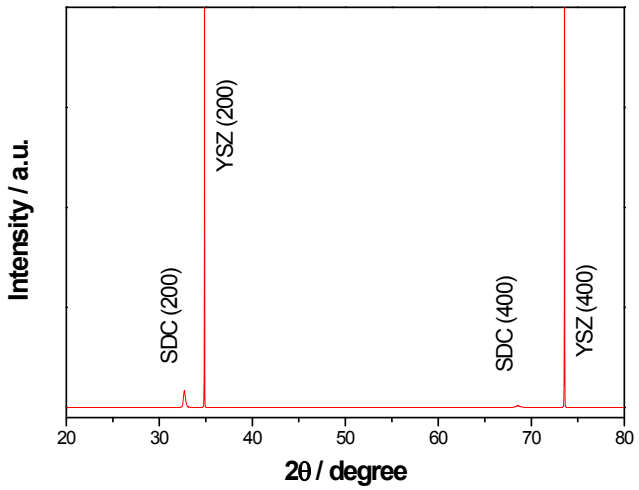

Fig. S4 Out-of plane X-ray diffraction patterns (2θ scan) for dense SDC interlayer with a thickness of 200 nm grown onto a (100) single-crystal YSZ substrate.

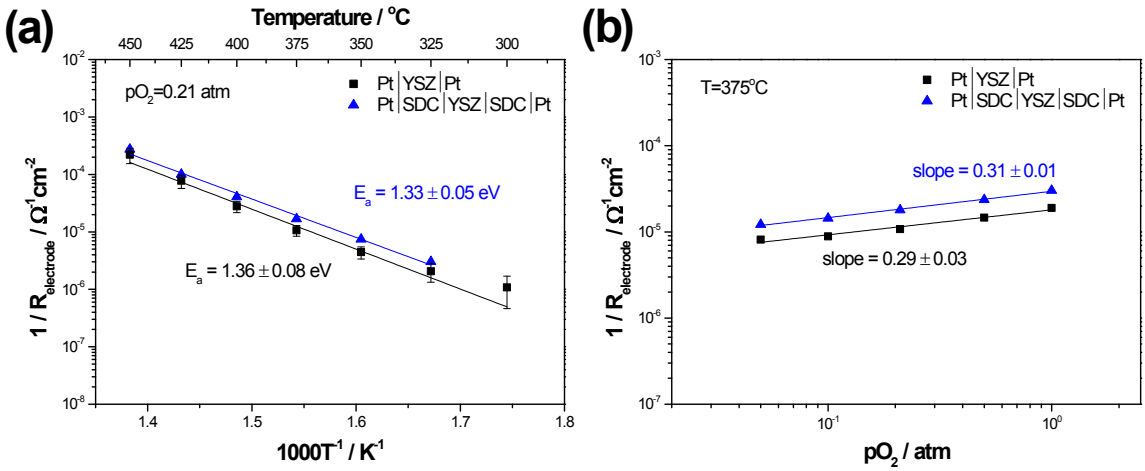

Fig. S5 (a) Temperature and (b) pO_2 dependence of the electrode conductance levels of Pt|YSZ|Pt (black) and Pt|SDC|YSZ|SDC|Pt (blue) cells. Dense SDC layers were inserted by pulsed laser deposition (PLD).

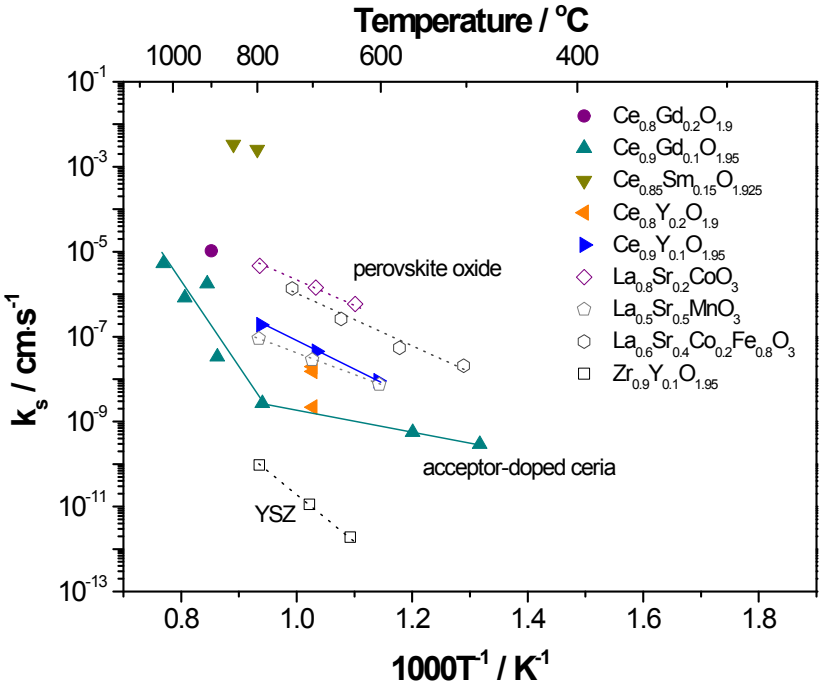

Fig. S6 Surface oxygen exchange coefficient (k_s) vs. temperature of doped ceria and other oxides. $Ce_{0.8}Gd_{0.2}O_{1.9}$ (Ref. 2), $Ce_{0.9}Gd_{0.1}O_{1.95}$ (Ref. 3), $Ce_{0.85}Sm_{0.15}O_{1.925}$ (Ref. 4), $Ce_{0.8}Y_{0.2}O_{1.9}$ (Ref. 3), $Ce_{0.9}Y_{0.1}O_{1.95}$ (Ref. 5), $La_{0.8}Sr_{0.2}CoO_3$ (Ref. 5), $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_3$ (Ref. 6), and $Zr_{0.9}Y_{0.1}O_{1.95}$ (Ref. 5).

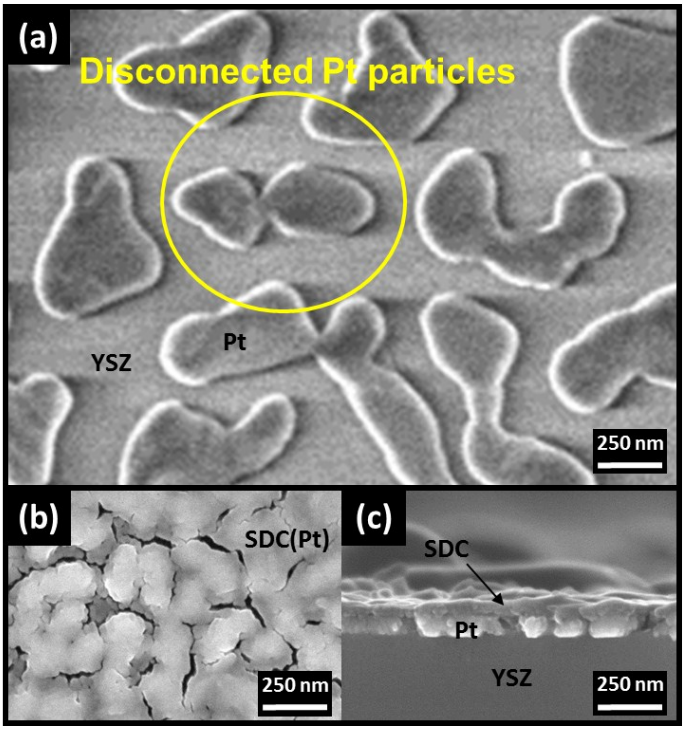

Fig. S7 SEM images of (a) bare and (b)/(c) CELD-coated Pt electrodes after annealing at 600°C, pO_2=0.21 atm for 40 h and 100 h, respectively. (b) top-view and (c) cross-section.

References

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