Supplementary information for

Up-Scaling of Electrolyte-Supported Solid Oxide Electrolysis Cells for CO_2 Reduction

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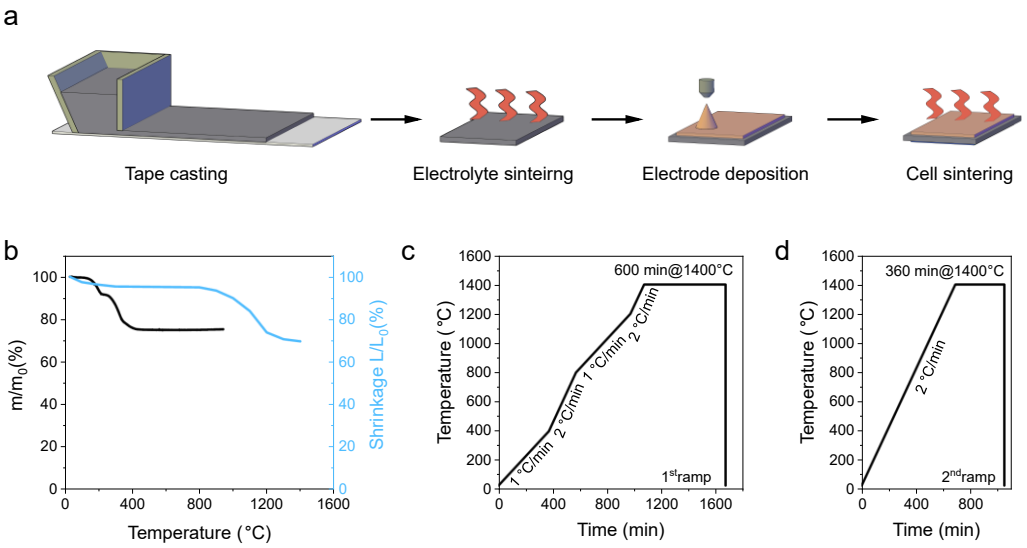

Fig. S1 Preparation of LSGM electrolyte-supported cell. a, 4 processes in cell preparation: tape casting, electrolyte sintering, electrode deposition, cell sintering. b, thermogravimetric analysis (TGA) and shrinkage of casted LSGM film. c and d, 1st and 2nd ramp profile during electrolyte sintering.

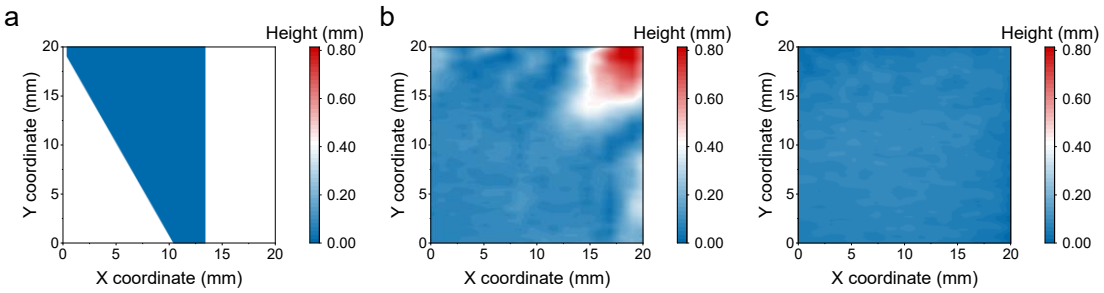

Fig. S2 3D profilometry mappings of electrolyte after sintering. a, constrained sintering (first ramp); b, stress-release sintering (first ramp); and c, stress-release sintering (second ramp).

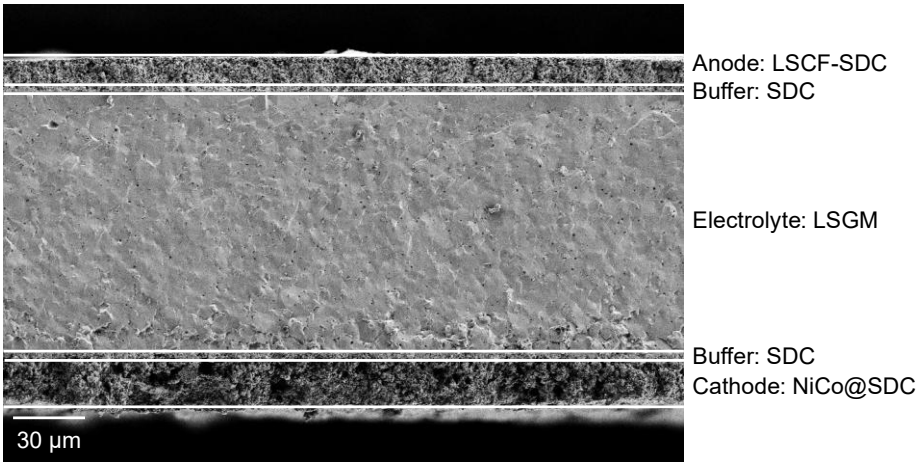

Fig. S3 Cross-sectional SEM image of the LSGM electrolyte-supported cell (ESC). The cell architecture comprises a 170 μm-thick LSGM electrolyte, a 5 μm SDC buffer layer positioned between the electrolyte and electrode, a 20 μm LSCF-SDC anode, and a 30 μm NiCo@SDC cathode.

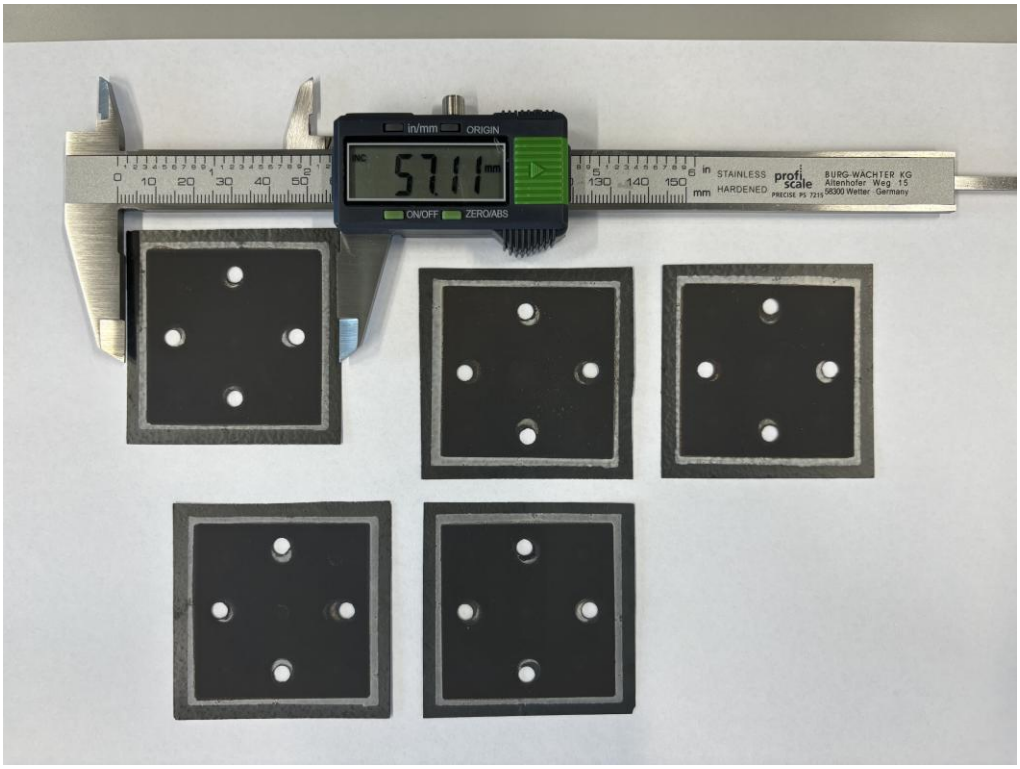

Fig. S4 Prepared 5×5 cm^2 LSGM electrolyte-supported cell with an active area of 17 cm^2.

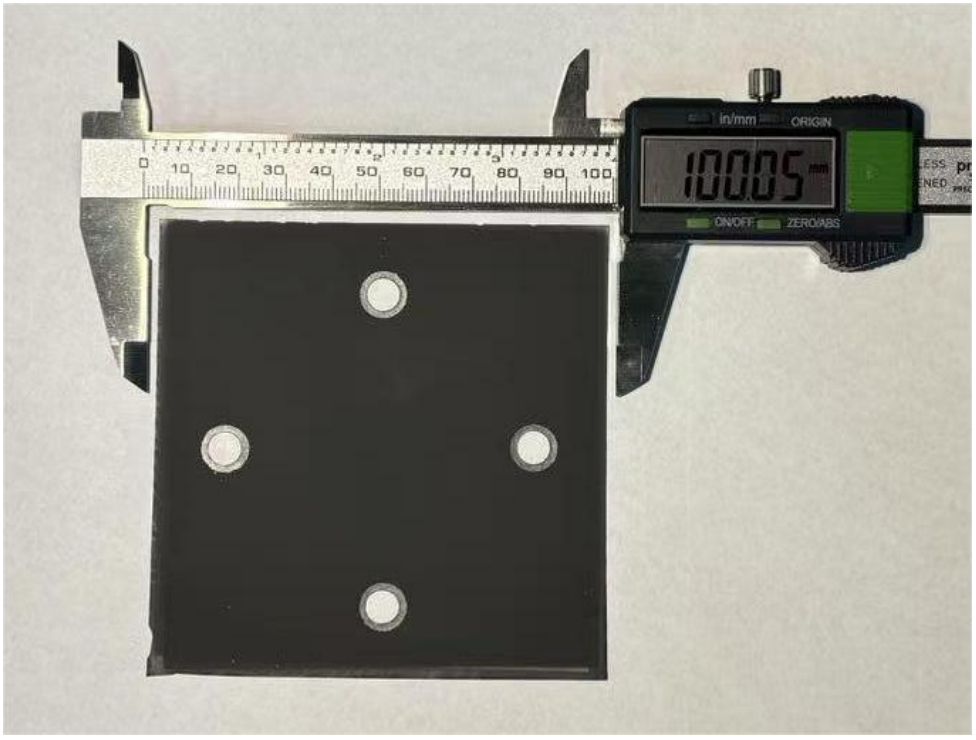

Fig. S5 | Prepared 10×10 cm^2 LSGM electrolyte-supported cell with an active area of 69 cm^2.

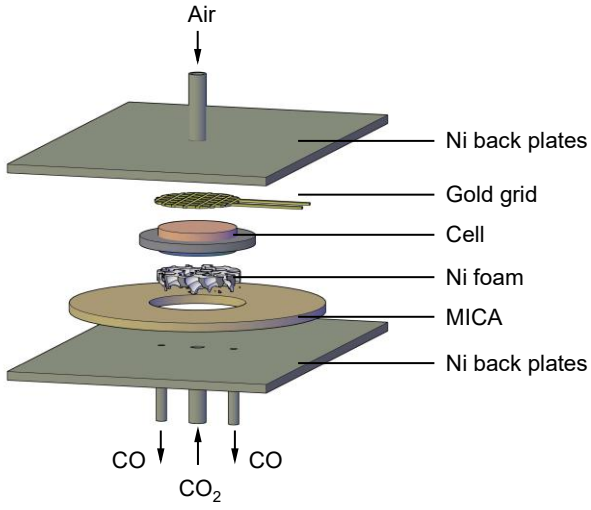

Fig. S6 Cell assembly for bottom-cell testing, adapted from our previous work.[1] The assembly is hosted between two Ni back plates, with mica serving as the sealing gasket, Ni foam as the cathode current collector, and a gold mesh as the anode current collector. CO_2 is introduced through the center, and CO is exhausted at the edges.

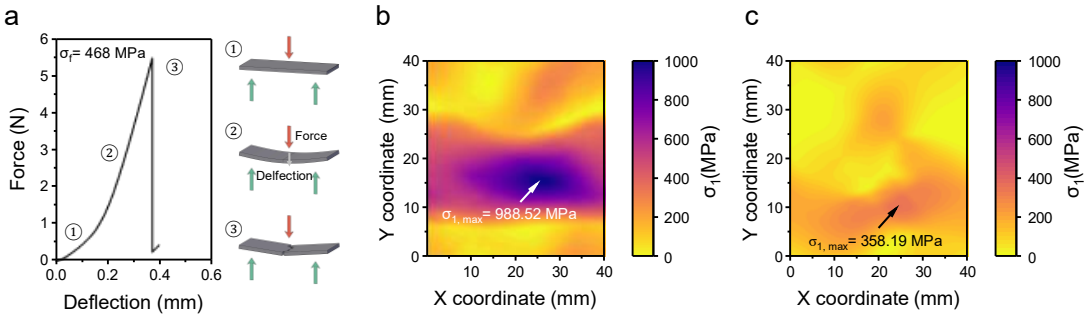

Fig. S7 Flexural strength of LSGM electrolyte-supported cell measured by three point bending test. a, Force–Displacement curve; the cell is supported at two edges, and a force is loaded to the center (①). As the force increases, the cell deforms by a deflection (②). At the maximum force load, the cell can't resist and break (③). b and c, the principal stress of the cell in assembly configuration of IC|Cell|IC and IC|NF|Cell|LSCF-NF|IC, respectively, with maximum corresponding to 988.52 MPa and 358.19 MPa.

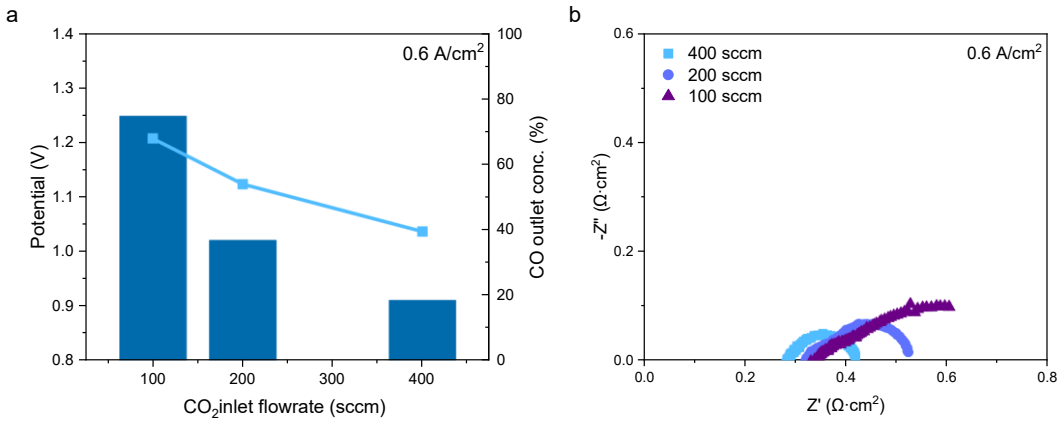

Fig. S8 LSGM ESC operating at low CO_2 flow rate. A, potential and CO outlet concentration, and B, EIS at different CO_2 flow rates with an applied current of 0.6 A/cm^2.

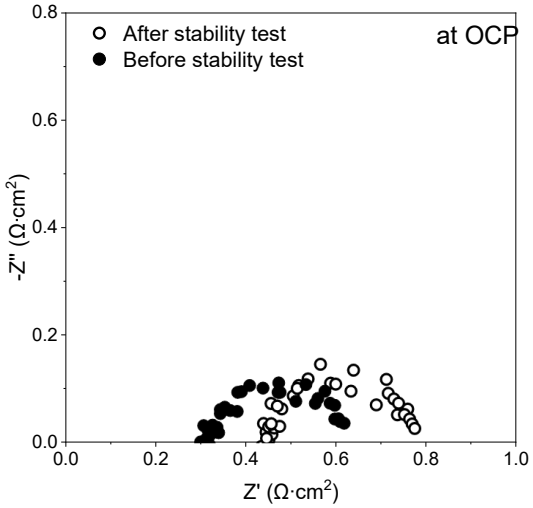

Fig. S9 EIS before and after stability test.

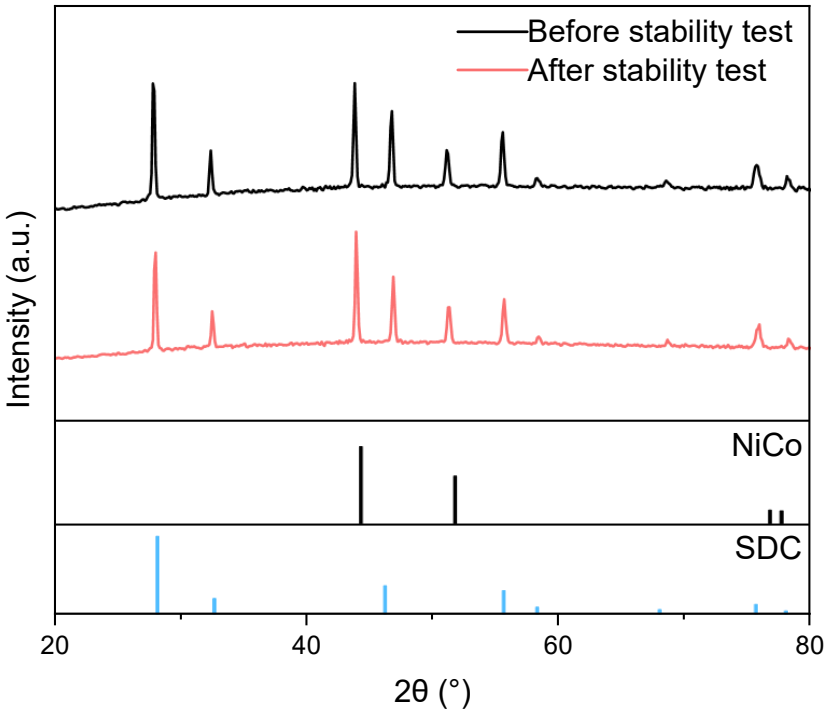

Fig. S10 X-ray diffraction (XRD) patterns of the NiCo@SDC catalyst. Data are shown for the catalyst before and after the stability test, indexed against standard NiCo and SDC reference patterns for comparison.

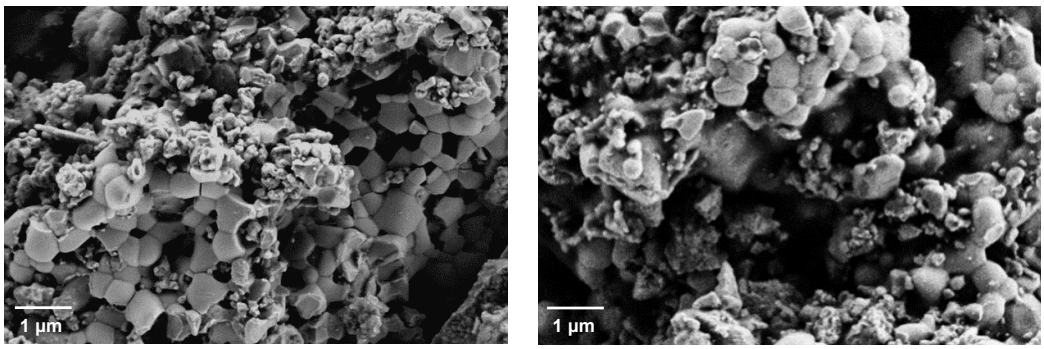

Fig. S11 SEM images of the NiCo@SDC catalyst before (left) and after (right) the stability test. The micrographs exhibit no significant morphological evolution, with no evidence of particle coarsening or SDC detachment. Notably, the core-shell structure is well-preserved after the test.

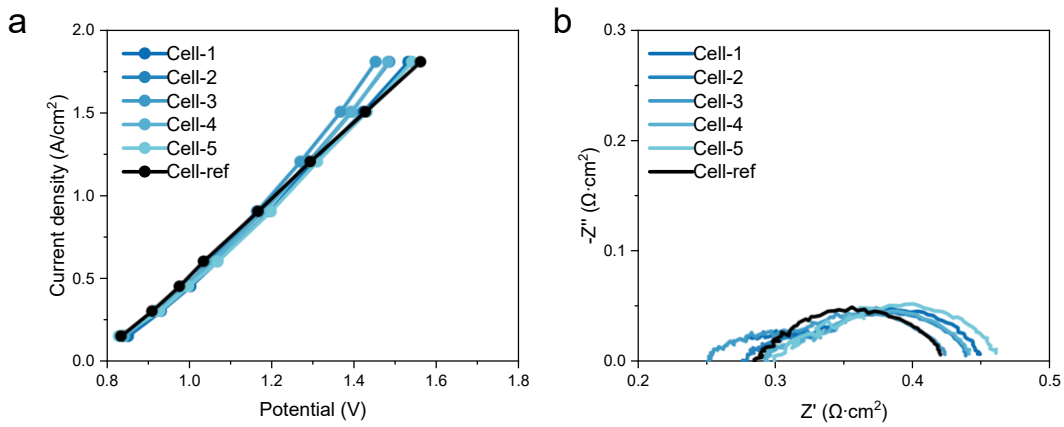

Fig. S12 Performance of one individual cell (Cell-ref) and a group of cells (Cell-1, Cell-2, Cell-3, Cell-4 and Cell-5) in a 5-cell stack. a, i-V curve, and b, EIS of Cell-1 to Cell-5 compared with that of an individual cell.

Reference

1 W. Ma, J. Morales-Vidal, J. Tian, M.-T. Liu, S. Jin, W. Ren, J. Taubmann, C. Chatzichristodoulou, J. Luterbacher, H. M. Chen and X. Hu, *Nature*, 2025, **641**, 1156.