Electronic Supplementary Information

$Pr_2BaNiMnO_{7-\delta}$ double-layered Ruddlesden-Popper perovskite oxides as efficient cathode electrocatalysts for low temperature proton conducting solid oxide fuel cells†

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Pore size distributions measurement

The pore size distribution of the anode support is measured by mercury porosimeter. For high-pressure mercury intrusion analysis, the anode support plates first vacuum-dried at 80 ℃ and then put into the mercury porosimeter (Auto Pore IV 9510, Micrometrics Instrument) for measurements. The injection pressure was increased from 0.10 psia up to 61,000.00 psia. Pore size of the anode support plates can be calculated by the Washburn equation $P_C = -2\gamma \cos\theta / r$, where γ is the surface tension of mercury, θ is the contact angle between mercury and the solid matrix, r is the pore radius and P_C is the injection pressure.[1]

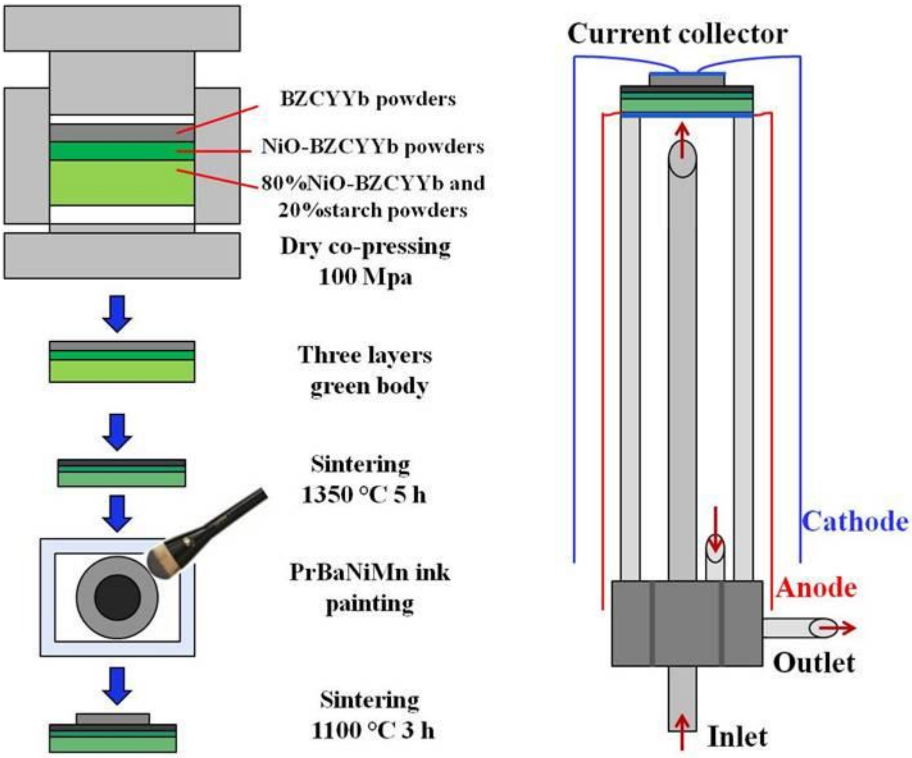

Fig. S1 The scheme of fabrication process for anode-supported single cells

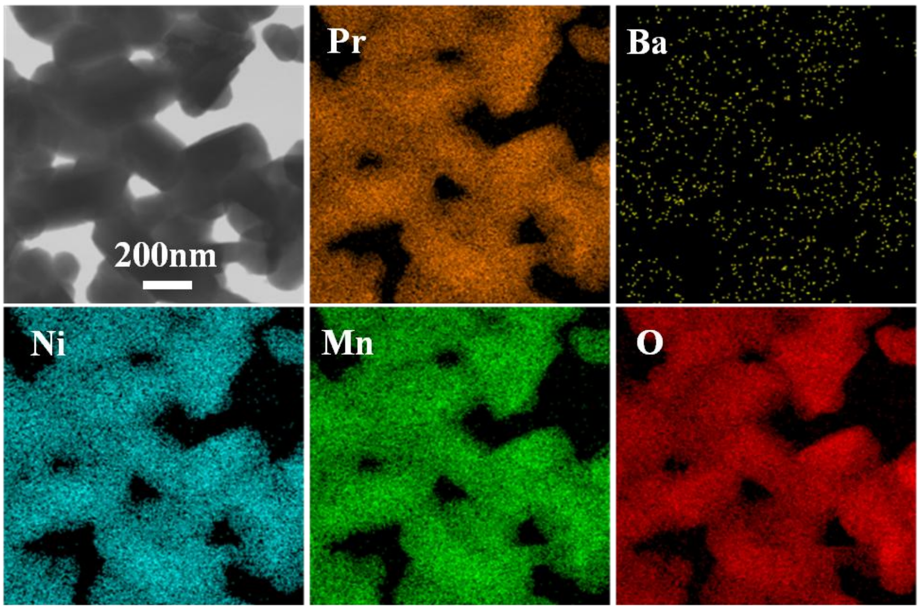

Fig. S2 The TEM image of PrBaNiMn powders and the corresponding energy dispersive X-ray spectroscopy (EDS) mapping images about Pr, Ba, Ni, Mn and O elements

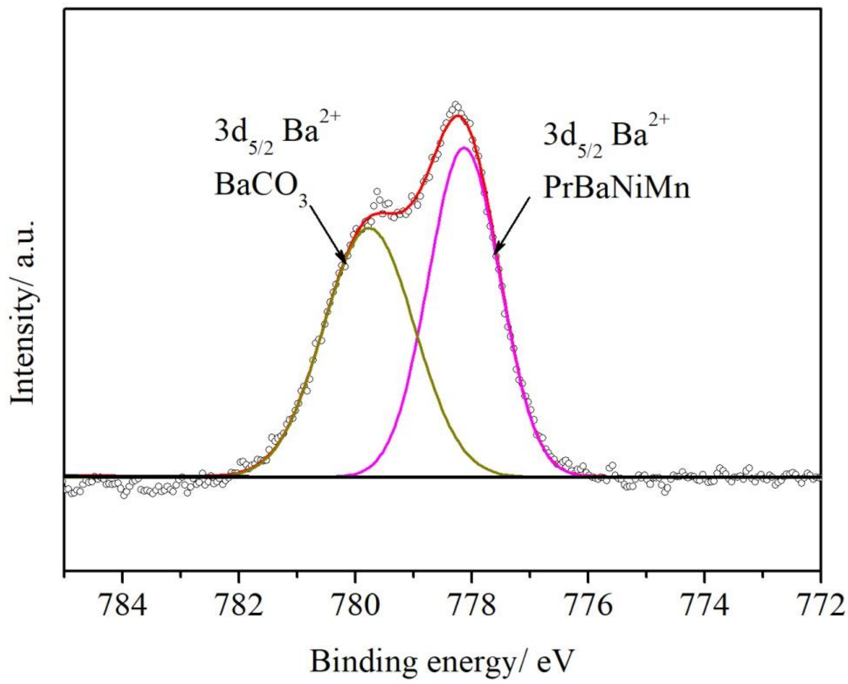

Fig. S3 Ba 3d core level XPS spectra of PrBaNiMn powders

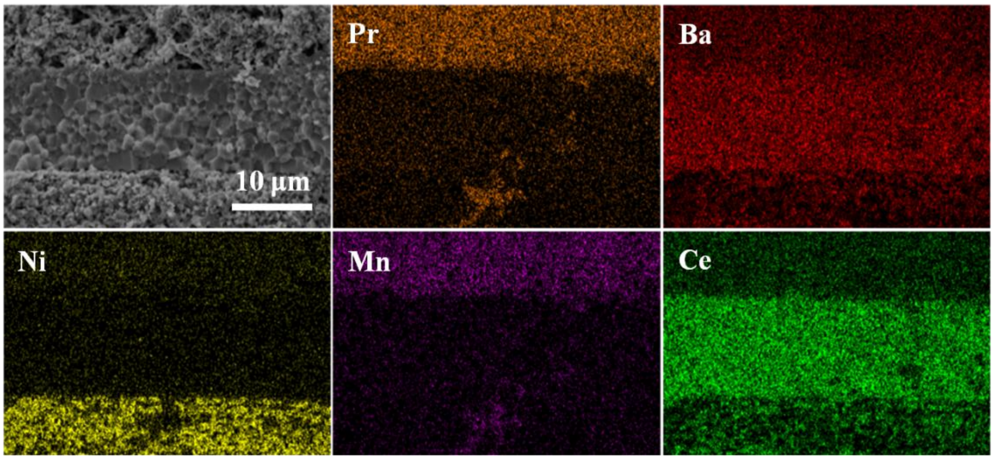

Fig. S4 The cross-section EDS mapping of the single cell after long term operation (including cathode, electrolyte and AFL)

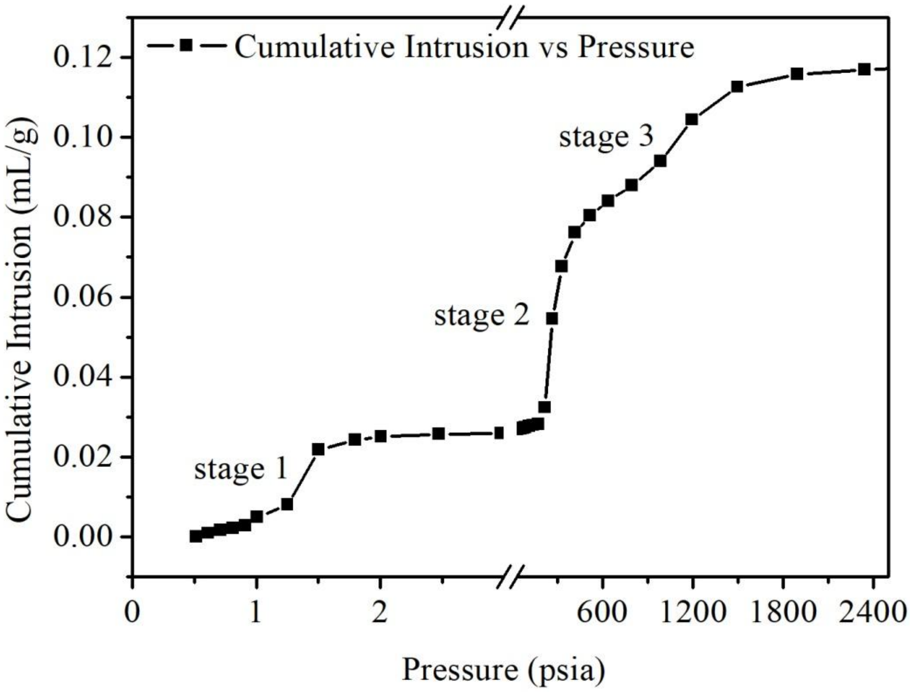

Fig. S5 Cumulative mercury intrusion (mL/g) versus pressure (psia) for the anode support plates

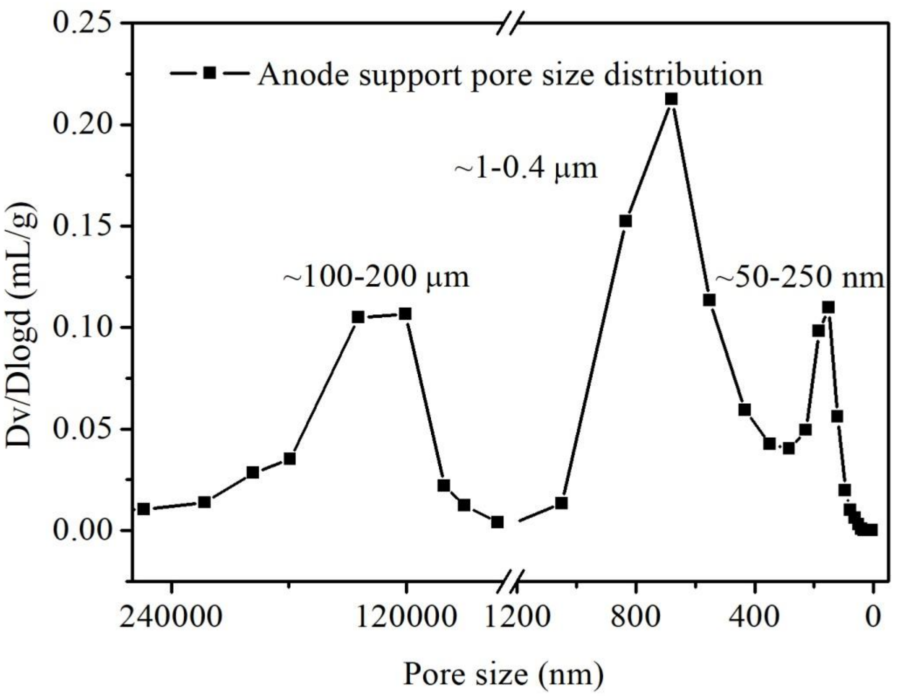

Fig. S6 Pore size distribution of the anode support plates with the mercury intrusion method

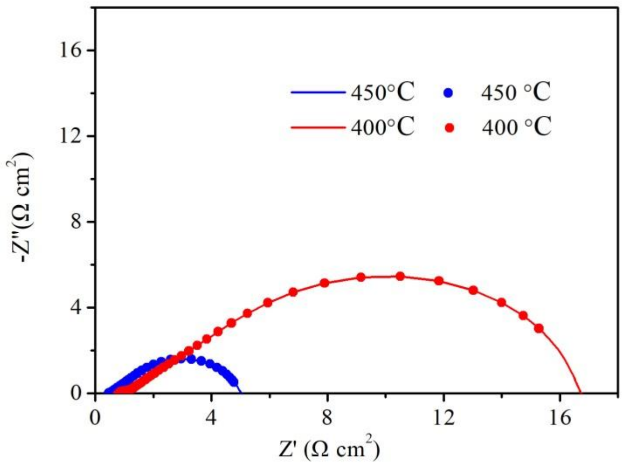

Fig. S7 The simulated EIS plots for the single cell (NiO-BZCYYb|AFL|BZCYYb|PrBaNiMn) at 400 ℃ and 450 ℃

Table S1. The temperature dependence of the ohmic resistance (R_O), polarization resistance (R_P) and total resistance (R_T), the ratio R_P/R_T, open circuit voltage (OCV) and peak power density (PPD) of the single cell with PrBaNiMn cathode with hydrogen (3% H_2O) as the fuel

T/℃	R_O/(Ω cm^2)	R_T/(Ω cm^2)	R_P/(Ω cm^2)	R_P/R_T	OCV/V	PPD/(mW/cm^2)
400	0.759	16.674	15.915	95.45	1.091	135
450	0.468	4.941	4.473	90.54	1.079	201
500	0.354	2.029	1.675	82.57	1.068	259
550	0.275	1.060	0.785	74.03	1.059	407
600	0.227	0.577	0.350	60.69	1.047	570
650	0.185	0.376	0.191	50.72	1.017	776
700	0.162	0.246	0.084	34.24	1.002	1070

1. K. Liu, M. Ostadhassan, L. Sun, J. Zou, Y. Yuan, T. Gentzis, Y. Zhang, H. Carvajal-Ortiz and R. Rezaee, *Fuel*, 2019, **245**, 274-285.