Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.
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Electronic Supplementary Information for:

A methane-fueled SOFC based on thin $BaZr_{0.1}Ce_{0.7}Y_{0.1}Yb_{0.1}O_{3-\delta}$ electrolyte film and $LaNi_{0.6}Co_{0.4}O_3$ anode functional layer

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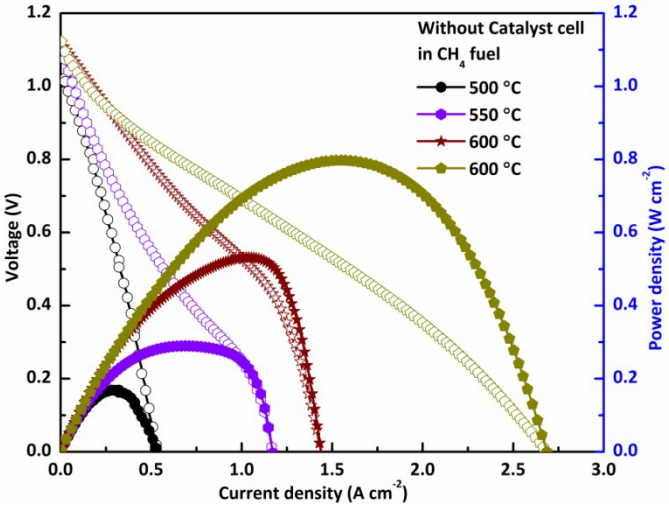

Fig. 1. *I–V* and *I–P* curves of anode supported single cell without a catalyst layer (NiO–BZCYYb/BZCYYb/LSCF–BZCY) under a humidified CH_4 fuel: The maximum power densities were 0.797, 0.53, 0.29, and 0.16 W cm^{-2} at 650, 600, 550, and 500 °C, respectively.

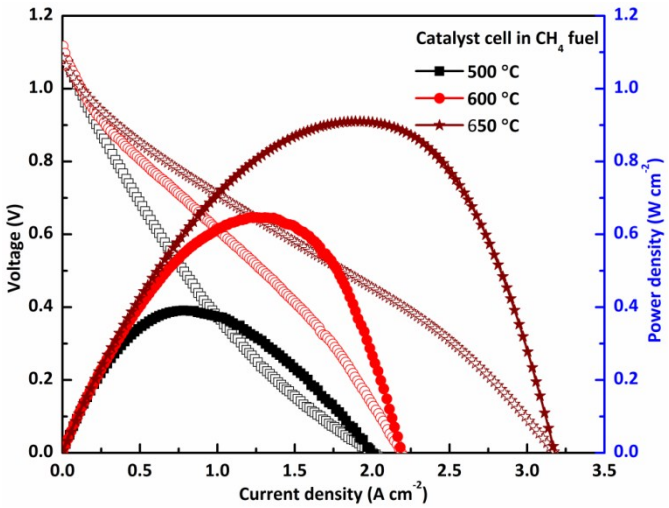

Fig. 2. *I–V* and *I–P* curves of anode supported single cell with a catalyst layer ($LaNi_{0.6}Co_{0.4}O_3$/NiO–BZCYYb/BZCYYb/LSCF–BZCY) under a humidified CH_4 fuel: The maximum power densities were 0.92, 0.66, and 0.39 W cm^{-2} at 650, 600, and 500 °C.

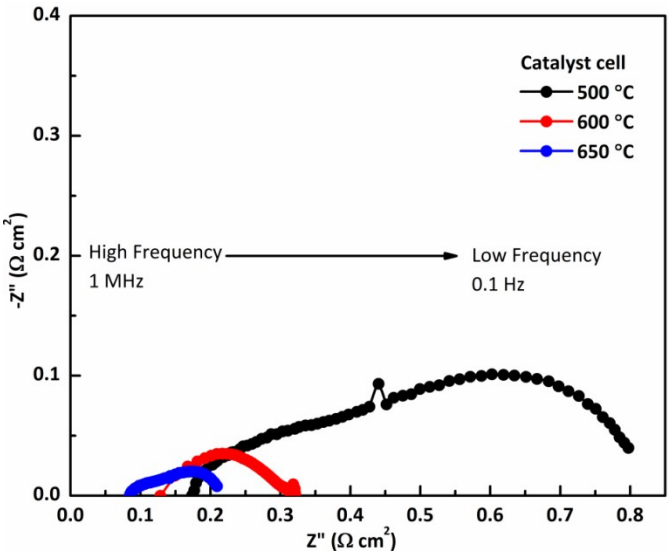

Fig. 3. The Impedance spectra of anode supported single cell with catalyst layer ($LaNi_{0.6}Co_{0.4}O_3$/NiO–BZCYYb/BZCYYb/LSCF–BZCY) under open circuit conditions: The ohmic and polarization resistances were calculated to be 0.08, 0.13, 0.18 Ω cm^2 and 0.14, 0.21, 0.62 Ω cm^2 at 650, 600, and 500 °C, respectively.

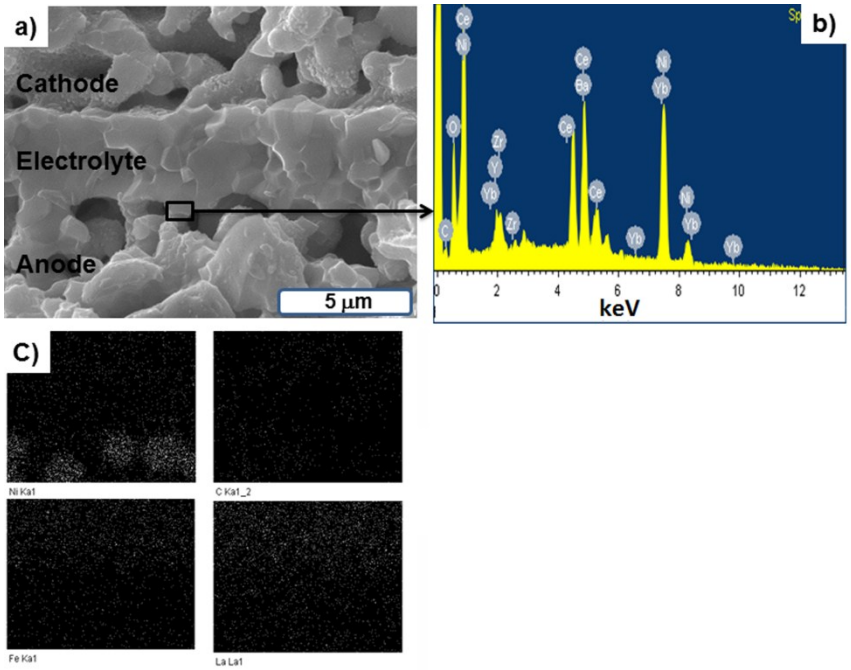

Fig. 4. (a) SEM cross-sectional image of a single cell without additional catalyst layer operated under methane fuel for 200 h. (b) A small area EDX is shown and all the initial constituent elements were present at the interface with almost no carbon deposition. (c) The area EDX map of Fig. 4a is shown. It was observed that all the elements remained at their respective positions with no any migration.

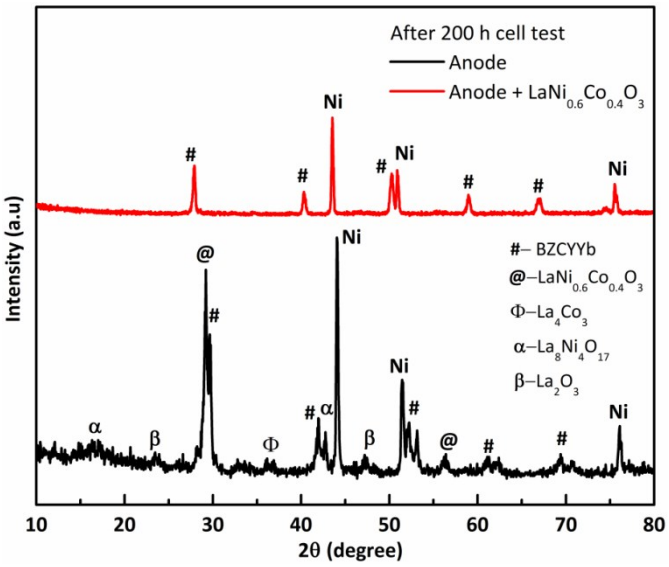

Fig. 5. The XRD analysis of the anode faces of single cells after cell test revealed that the Ni catalyst remained active with high crystallinity. Further, no degradation of the constituent phases of the anodes with and without catalyst layer was observed.