# Highly Active Hybrid Catalyst Impregnated Cathode for Proton Conducting Solid Oxide Fuel Cells

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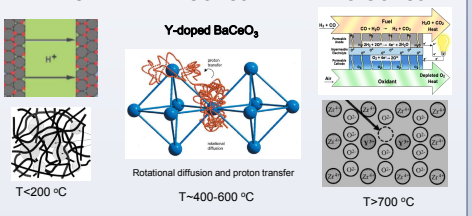
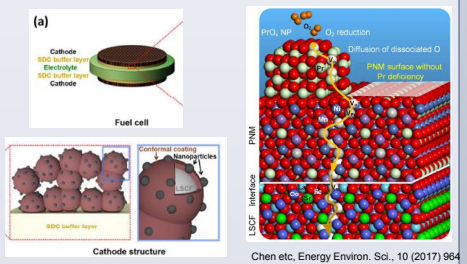
## Introduction

PEM FC | P-SOFCs | O-SOFCs




ORR can be enhanced by adding a nanostructured catalyst on the electrode via infiltration/impregnation technique.

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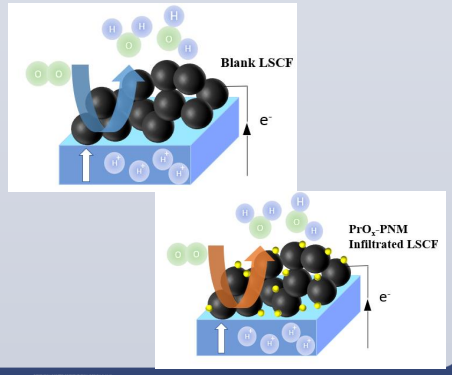
## Research Objectives

The sluggish reaction kinetics in the cathode usually hinders the development of H-SOFCs operated at intermediate temperatures (400-650°C).

To improve the reaction kinetics of cathode, a novel hybrid catalyst consisting of $PrNi_{0.5}Mn_{0.5}O_3$ and $PrO_x$ is impregnated in the $(La_{0.60}Sr_{0.40})_{0.95}Co_{0.20}Fe_{0.80}O_{3-\delta}$ (LSCF) cathode of H-SOFCs.




## Result and Discussion

### Part I Phase and Microstructure Characterization

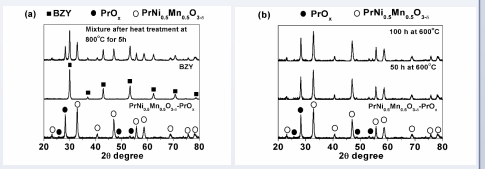



**Figure 1** XRD patterns (a) chemical compatibility between $PrNi_{0.5}Mn_{0.5}O_3$, $PrO_X$, and BZY; (b) Stability of $PrNi_{0.5}Mn_{0.5}O_3$ and $PrO_X$.

Hybrid catalyst is chemically compatible with $BaZr_{1-x}Y_xO_3$ (BZY) and shows good phase stability.

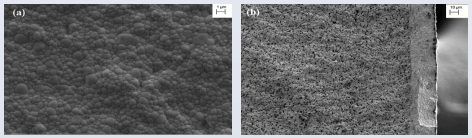



**Figure 2** FESEM images of the single cells. (a) The surface of the BZY electrolyte; (b) The cross-section view of NiO-BZY anode and BZY electrolyte.

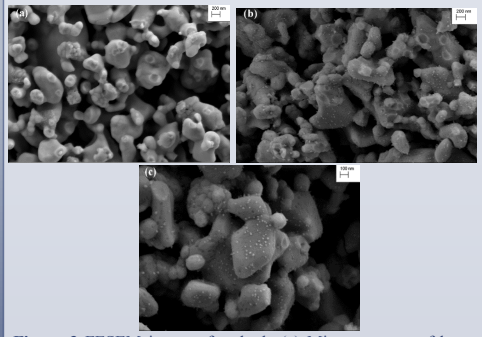



**Figure 3** FESEM image of cathode (a) Microstructure of bare LSCF electrode; (b) Microstructure of LSCF electrode with $PrNi_{0.5}Mn_{0.5}O_3$ and $PrO_X$; (c) High magnification of image of LSCF electrode with $PrNi_{0.5}Mn_{0.5}O_3$ and $PrO_X$.

H-SOFCs with hybrid catalyst impregnated LSCF cathode have been successfully fabricated.

### Part II Electrochemical Characterization

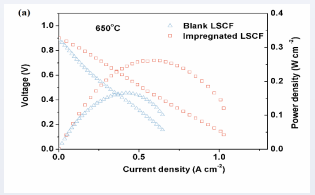



**Figure 4** Electrochemical performance of single cells (a) I-V curves; (b) Maximum powder densities of single cells at various temperature.

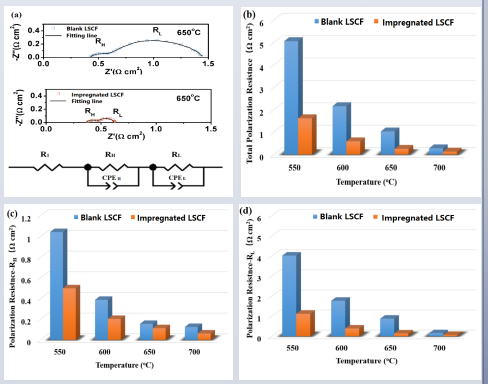



**Figure 5** (a) Impedance spectra Impedance spectra of single cells at 650 °C; (b) Polarization resistance of single cells at various temperatures; (c) Polarization resistance $R_H$ at various temperatures; (d) Polarization resistance $R_L$ at various temperatures.

Hybrid catalyst can greatly enhance the reaction kinetics of cathode, resulting in significant improvement of electrochemical performance of H-SOFCs, especially at lower temperatures.

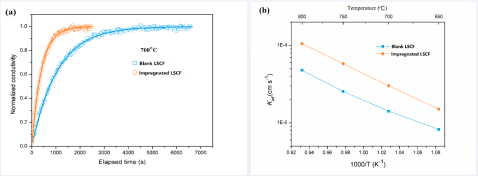



**Figure 6** (a) Electrical conductivity relaxation as a function of time at 700°C; (b) Plots of the surface exchange coefficients ($K_{eff}$) as function of temperatures.

Impregnation of hybrid catalyst can improve not only the kinetics of oxygen-ion transfer but also oxygen dissociation-absorption process (oxygen surface exchange) in the LSCF cathode, resulting in significant reduction of $R_P$, $R_H$ and $R_L$.

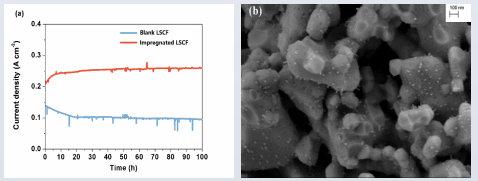



**Figure 7** Stability of single cells at 600 °C (a) Operation of single cells at 0.6 V; (b) The microstructure of electrode after 100 h test.

## Conclusion

Impregnation of hybrid catalyst is a promising approach to improve the performance and durability of LSCF cathode for H-SOFCs.

## Acknowledgement

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