Supplementary Materials

Simultaneous enhancement of H_2 and O_2 Permeation in Proton Ceramic Honeycomb Hollow Fiber Membranes by Fe^{3+} and Y^{3+} co-doping

Lihui Wang[1], Shao Zhang[2], Mingming Wang[1,2*], Zhigang Wang[1,2*], Xiaoyao Tan[1*]

[1] State Key Laboratory of Advanced Separation Membrane Materials, Department of Chemical Engineering, Tiangong University, Tianjin 300387, P.R. China

[2] Hebei Industrial Technology Research Institute of Membranes, Cangzhou Institute of Tiangong University, Cangzhou 061000, China

1. The micromorphology of BZCF, Y-BZCF and Fe-BZCY honeycomb-structured hollow fiber membranes

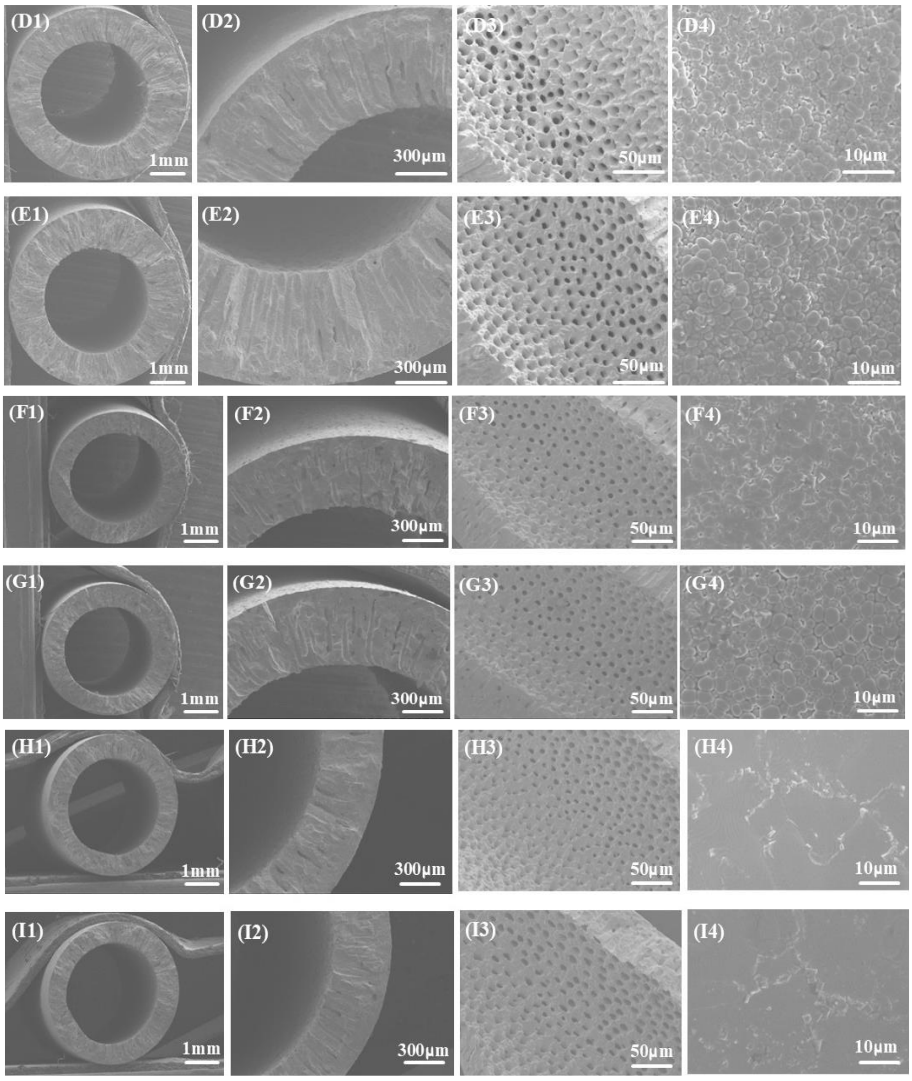


Figure S1. The scanning electron microscopy (SEM) micrographs of the hollow fiber membranes, including (D, E) $BaCe_xFe_{1-x}Zr_{0.2}O_{3-\delta}$(BCZF) sintered at 1350°C, 5h, (F, G) $BaCe_{1-x}Fe_{0.2}Zr_{0.2}Y_xO_{3-\delta}$(Y-BZCF) sintered at 1350°C, 5h, and (H, I) $BaCe_{1-x}Fe_xZr_{0.2}Y_{0.2}O_{3-\delta}$(Fe-BZCY) sintered at 1490°C, 5h doped with different concentrations. Among them, (Among them, 1，the cross-sections of the hollow fiber membranes; 2，the magnified cross-sections; 3, display the inner surfaces; and 4, the outer surfaces).

2. The XRD patterns of BZCF, Y-BZCF and Fe-BZCY honeycomb-structured hollow fiber membranes

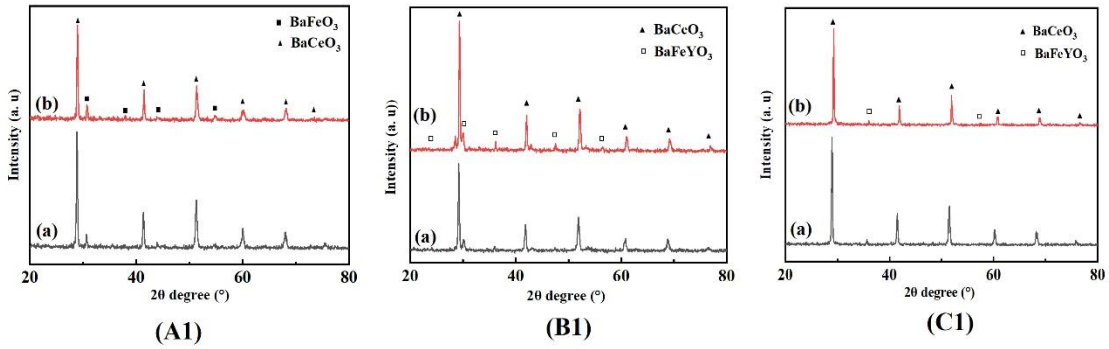


Figure S2. XRD images of A1, $BaCe_xFe_{1-x}Zr_{0.2}O_{3-\delta}$(BZCF): (a)$Fe^{3+}$=0.1; (b) Fe^{3+}=0.15; B1, $BaCe_{1-x}Fe_{0.2}Zr_{0.2}Y_xO_{3-\delta}$(Y-BZCF): (a) Y^{3+}=0.1; (b)Y^{3+}=0.15; and C1, $BaCe_{1-x}Fe_xZr_{0.2}Y_{0.2}O_{3-\delta}$(Fe-BZCY): (a)$Fe^{3+}$=0.1; (b)$Fe^{3+}$=0.2 honeycomb-structured hollow fiber membranes with different Fe^{3+} and Y^{3+} doping concentrations.

3. Conductivity measurements for honeycomb-structured hollow fiber membranes .

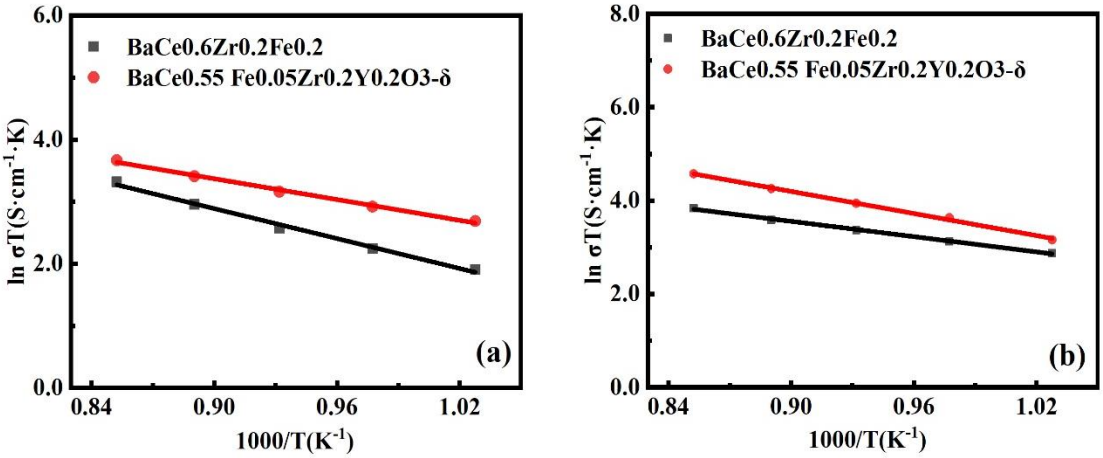


Figure S3 Temperature dependence of conductivity for $BaCe_{0.6}Zr_{0.2}Fe_{0.2}O_{3-\delta}$ and $BaCe_{0.55}Zr_{0.2}Y_{0.2}Fe_{0.05}O_{3-\delta}$ under (a) dry hydrogen atmosphere and (b) air atmosphere.