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Y-doped $BaZrO_3$ as a chemically stable electrolyte for proton-conducting solid oxide electrolysis cells (SOECs)

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Experimental Section

The Y-doped $BaZrO_3$ (BZY) electrolyte films were fabricated on the $BaZr_{0.8}Y_{0.2}O_{3-\delta}$(BZY20)-NiO composite fuel electrode by an ionic diffusion method. The details for this method are described in a previous paper (*Energ Environ Sci. 2011, 4, 409*). In order to test the chemical stability of the supported electrolyte films, the BZY films were treated in boiling water for 3 h and in steam (3%) at 600 ^oC for 24 h, respectively. The steam condition was achieved by bubbling air through water at room temperature with a flowing rate of 100 mL min^{-1} and the steam was fed during the whole heating and cooling procedure, not only at 600 ^oC, in order to check the BZY film stability during the heating and cooling process. X-ray diffraction (XRD) analysis was used to identify the phases present in the BZY films before and after these treatments. The XRD measurements were carried out using Bruker D8 Advance diffractometer with Cu $K\alpha_{1,2}$ (λ = 1.540600, 1.544390 Å) radiation. The room temperature patterns were collected between 20° and 80° with a step width of 0.019714°. The morphologies of the electrolyte membrane film were determined using a Quanta 200 scanning electron microscope (SEM).

A slurry of a $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-\delta}$-$BaZr_{0.8}Y_{0.2}O_{3-\delta}$ mixture in a 1:1 weight ratio was printed on the sintered BZY electrolyte film and then fired at 1000°C for 3 h to form a porous air electrode. The single electrolysis cell was tested at different temperatures with humidified air (~ 3% H_2O) fed at the air electrode side and Ar containing 4% H_2 fed at the fuel electrode side. The flowing rate of humidified air was set at 100 mL min^{-1} at the air electrode side, while Ar gas containing 4% H_2 was fed at the fuel electrode side with a flowing rate of 200 mL min^{-1}. The performance of the electrolysis cell was recorded with a multichannel potentiostat Solartron 1470E (Solartron Cell Test System). The long-term stability test was carried out under the electrolysis cell working condition with an applied voltage of 1.3 V at 600 ^oC. The morphologies of the BZY electrolysis cell before and after testing were observed by using a Quanta 200 SEM.

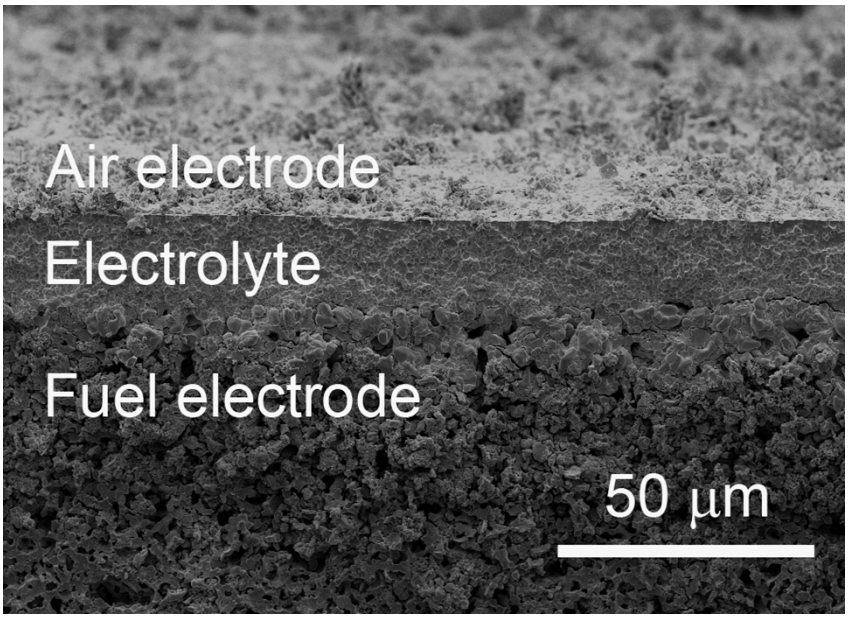

Figure S1. Cross-sectional SEM micrograph of the BZY electrolysis cell after long-term stability test, showing no damage or crack in the BZY electrolyte film