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ABSTRACT:

Desing of Proton Conducting Nanostructured Materials for Intermediate Temperature Hydrogen Technologies

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Proton-conducting oxides represent a class of solid-state ion-conducting ceramic materials that exhibit remarkable proton conductivity at intermediate temperatures (e.g., 500–750 °C). These oxides are attracting considerable attention as forefront materials for ceramic-based hydrogen technologies, including Solid Oxide Cells (operating in both fuel cell and electrolysis modes) and Separation Membranes. This contribution summarizes the advancement on the design, processing and application of barium cerate zirconate-based and ceria-salts nanocomposites, which exhibit unique properties and significant performance enhancement when applied to hydrogen technologies. Composite electrolytes of sodium carbonate and samarium doped ceria (SDC-Na_2CO_3), synthesized by co-precipitation, demonstrated exceptional proton conductivities (up to 2.27x10^{-2} S cm^{-1}) in dry hydrogen at 600°C, serving as innovative electrolyte for Solid Oxide Cells. The synthesis procedure employed has been confirmed to play a pivotal role in determining the composite's proton conductivity [1]. For the same application, $BaCe_{1-x-y-z}Zr_xY_yYb_zO_{3-\delta}$ (BCZYYb) were produced using various methods to assess the impact of the production process on the microstructure and phase purity of the final electrolytes. The sol-gel synthesis has been identified as one of the most promising methods for producing pure, high-density electrolytes with superior conductivity properties (1.4 x10^{-2} S/cm^{-1} at 600°C). For dense all-ceramics hydrogen separation membranes, a reproducible methodology was developed to apply nanostructured BCZY-GDC wash-coat on symmetric cer-cer membranes using aqueous-based dip coating to investigate the influence on the hydrogen separation ability. It was found that hydrogen permeated flux increases by a factor > 2.5 when a 3.5 µm porous coating was deposited on both sides of the membranes.

[1] S. Casadio, M.C.D. Lacharme, A. Donazzi, A. Gondolini, Int. J. Hydr. En. 58 (2024) 1324-1331.