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Protonic Conducting Ceramic for 300-400 ° C

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Combining high protonic conductivity with thermodynamic stability is considered to be a key problem for high temperature protonic conducting ceramic (HTPC) membranes for electrochemical applications. The objective was to gain an understanding of the relationship of crystallite size, grain boundaries and defect chemistry on proton conduction and thermodynamic stability. We developed an analytical method using concurrent techniques of high-resolution transmission electron microscopy, impedance spectroscopy and nuclear microprobe to reveal spatial distribution of hydrogen. In our recent work, we shown that high-density of defects exist in the microstructure can reduce the level of proton incorporation. The results showed that hydrogen is concentrated at the grain boundaries where the hydrogen mobility is low. Perovskite structure $\text{BaCe}_{1-x}\text{Y}_x\text{O}_{3-\delta}$ (BCY) and $\text{BaZr}_{1-x}\text{Y}_x\text{O}_{3-\delta}$ films were deposited using pulsed laser deposition system on porous structures to provide mechanical strength. The ease with which the stoichiometry of a multi-component system can be maintained in the deposited films using pulsed laser deposition approach offered a significant advantage over other conventional film deposition techniques. Impedance spectroscopy was used to investigate protonic conductivity of high-density $\text{BaCe}_{1-x}\text{Y}_x\text{O}_{3-\delta}$ (BCY) and $\text{BaZr}_{1-x}\text{Y}_x\text{O}_{3-\delta}$ (BZY) films (2 - 5 μm). The crystallite size, grain boundaries and defect chemistry were characterized by XRD, SEM, TEM and HRTEM which showed the adverse effect of grain and domain boundaries. Variation of the process parameters, in particular of the substrate temperature, induced changes in the microstructure of the films and in their conductivity. Columnar grains enclosing reduced density of defects were seen to yield the best proton conductivities.