Properties of Yttrium doped Barium Hafnate Proton Conductor

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Abstract

Proton-conducting solid-electrolyte of ceramic nature based on acceptor-doped barium and strontium perovskites are potential candidate materials for high drain electrochemical devices, e.g. fuel cells that operate at moderate temperatures. In order to evaluate the feasibility of a fuel cell with these materials, it is necessary to take into account properties like the bulk electrolyte conductivity and the chemical stability under fuel cell operating conditions.

Ba-cerates are probably the best known example of high temperature proton-conducting perovskites but their poor stability in CO2-containing atmospheres make them less attractive for application in fuel cells. Ba-zirconate, although slightly inferior to Ba-cerate for as far as the proton conductivity is concerned, is still a rather favorable proton conductor, since it shows good chemical stability in CO2 over the temperature range of interest.

In this study, properties like phase composition, proton conductivity and chemical stability of BaZr0.9Y0.1O3-δ, BaCe0.9Y0.1O3-δ and BaHf0.9Y0.1O3-δ were investigated and as such a comparison of these three compounds is possible. Quite some analogy is found between doped Ba-cerates, Ba-zirconates and Ba-hafnates. It appears that thermal processing causes the formation of a secondary phase at the surface. For cerates this phase is an Y-containing CeO2-phase that shows up as precipitates that strongly decorate the grain boundaries at the surface of the sample.

The proton conductivity was determined by means of impedance spectroscopy. Y-doped Ba-hafnates demonstrates a same level of proton conductivity as is found for Y-doped Ba-zirconate, so slightly inferior to the proton conductivity of doped Ba-cerate. This is in agreement with the fact that the Hf4+ -ion has about the same ionic radius as the Zr4+ -ion, 0.79 and 0.78 respectively, which is smaller than the radius of the Ce4+ -ion (0.92). In addition it is found that BaHf0.9Y0.1O3-δ does not show formation of BaCO3 in a CO2-atmosphere.