Mixed Conducting Perovskites as Solid Oxide Fuel Cell Cathode Materials: Insight from Experiments and Theory

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Slow kinetics of the oxygen reduction reaction at the cathode is one of the main limiting factors for the performance of solid oxide fuel cells. The cathode material should not only conduct electronic carriers, but also transport ions between the electrolyte and the interface to the gas phase allowing the reaction to extend beyond the electrolyte/electrode/gas triple phase boundary. Thus, for fuel cells based on proton conducting oxides such as Y-doped $BaZrO_3$, mixed proton/hole conducting oxides are highly desired. The defect chemistry of such materials will be discussed on the example of $Ba_{0.5}Sr_{0.5}Fe_{0.8}Zn_{0.2}O_{3-\delta}$ (BSFZ) perovskite based on thermogravimetry experiments [1] and numerical simulations. Trends concerning water incorporation into related perovskites will further be analyzed with the help of ab initio calculations.

The kinetics of the oxygen exchange reaction for BSFZ on $Ba(Zr,Y)O_{3-\delta}$ electrolytes is investigated on dense thin film microelectrodes by impedance spectroscopy [2]. The results indicate that the proton conductivity of BSFZ indeed suffices to transport protons from the $Ba(Zr,Y)O_{3-\delta}$ electrolyte through the dense BSFZ film to the gas interface, where O_2 is reduced to water. This also means that oxygen is not necessarily incorporated into the perovskite to perform the reduction reaction. The results are compared to cathode materials on oxide ion conducting electrolytes (YSZ, CGO). For perovskites such as $(La,Sr)MnO_{3-\delta}$ or $Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{3-\delta}$ on YSZ, the reaction mechanism is quite well-understood based on experimental correlations [3] and ab initio calculations [4].

References

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