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Phases of electrolytes controlled the degradation behavior in electrolyte-supported solid oxide fuel cell

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Metal oxide membranes for solid electrolytes are critical components in high temperature electrochemical energy converters such as ceramic fuel cells and electrolyzers, and thus of high relevance for a sustainable energy economy. However we found that the major degradation of conductivity in the electrolyte-supported fuel cell stacks is caused from decay of ions conductivity contribution. Results from impendence spectra show that the part of ion conduc-tivity through the grain decreases and almost keeps the same values in the contribution through grain boundary.
In this work, we applied the X-ray and Neutron powder diffraction on long term operated electrolyte material, 12 moles% Scandia doped stabilized zirconia (6ScSZ) from the real commercial electrolyte-supported fuel cell stacks. In the ScSZ phase equipment diagram, the Scandia elements doping stabilized zirconia shows the major phases in the structure would be separating into tetragonal T'and cubic T"phases. The phase transition between 2 phase groups in the SZ is not controlled by diffusion process but rather with oxygen vacancies slightly displaced and ordered in the unit cell and transforms from cubic to tetragonal P42/NMC symmetry. In our quantitative phase analysis, the results also supported the phase composition changed with different aged time. After 1250 hours aged, the amount of tetragonal phase grows. Furthermore, in our observation, the transport properties can be healed after annealing above 1300 degree and the phase composition returned to one as pristine 6ScSZ.

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