Solid oxide cells (SOC) are electrochemical devices that can operate efficiently both in fuel cell (solid oxide fuel cell, SOFC) and electrolysis mode (solid oxide electrolysis cell, SOEC). However, long-term performance degradation hinder the widespread commercialization of this technology. Nickel coarsening is a major cause of the decrease of the cells’ performance. Therefore, investigating and quantifying effects of nickel coarsening on the microstructural evolution in SOCs is crucial to understand the degradation processes occurring during operation.

Focused-ion-beam scanning electron microscopy (FIB-SEM) tomography and phase field (PF) modelling are used to investigate the microstructure evolution of Ni/Yttria-Stabilized Zirconia (YSZ) SOC fuel electrodes. A cell, tested as part of a 25 cells stack for 9000 hours, and a reference cell (never operated) are reconstructed using FIB-SEM tomography. Microstructural parameters were calculated on the two cells showing that the percolated triple phase boundary (TPB) length in the cell decreases from 1.85 μm/μm3 for the reference cell to only 1.01 μm/μm3 for the long-term tested one.

Phase field simulations were run on the reference cell geometry and microstructural parameters such as particle size distribution (PSD), TPB length and surface areas are computed and quantified on the simulated volumes. A trend of decreasing percolated TPB length with time is observed in the simulations. The numerical results are used to investigate the effects of nickel coarsening as well as to obtain information on the kinetics of the phenomenon.

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