NAPLES, ITALY 23-27 JUNE
DSL2025 NAPLES
21st International Conference on Diffusion in Solids and Liquids

ABSTRACT

Nanoscale Surface Modification of Perovskite Electrodes for Solid Oxide Cells

Haoyang Li[1], Jiyoon Shin[1], Jeong Woo Shin[1], and Pei-Chen Su[1,2]

[1]School of Mechanial and Aerospace Engineering, Nanyang Technological University, Singapore
[2]Energy Research Institnte at Nanyang Technological University (ERI@N), Singapore

Solid oxide cells (SOCs) rely on efficient oxygen-ion diffusion and stable ionic conduction, yet perovskite electrodes such as $Sr_2Fe_{1.5}Mo_{0.5}O_{6-\delta}$ (SFMO) suffer from Sr cation segregation and surface degradation, which degrade ionic transport pathways and accelerate performance decay. To address these challenges, this work employs nanoscale surface engineering—via atomic layer deposition (ALD) and solution infiltration—to tailor oxygen vacancy distribution, suppress cation mobility, and enhance interfacial stability in SFMO electrodes. ALD-derived coatings passivate surface defects, reducing Sr segregation after 50 hours of operation, while infiltration with nanoscale catalysts optimizes oxygen exchange kinetics at the triple-phase boundary. Structural and electrochemical analyses reveal that these modifications significantly enhance electrode surface reactions and reduce polarization resistance, attributed to engineered oxygen vacancy gradients and stabilized bulk-to-surface diffusion pathways. Impedance spectroscopy further demonstrate lowered activation energy for oxygen migration, linking nanoscale defect engineering to improved ionic transport efficiency. The findings underscore the critical role of surface chemistry in governing ionic conduction, where controlled oxygen vacancy dynamics and interfacial passivation mitigate diffusion barriers and extend electrode longevity. This study advances the design of durable, high-performance SOCs by bridging nanoscale surface modification with macroscopic solid-state ionic behavior, offering insights applicable to the optimization of inorganic compounds for fast-ion conduction and energy conversion technologies.

Keywords: Ionic conduction, oxygen vacancy, perovskite electrodes, surface modification, solid oxide cells, cation segregation