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

ABSTRACT

Impact of Ni Redox Reactions on Electrolyte Stress in Anode Supported SOFCs

M. Yamaguchi[1], Y. Morishita[1], T. Komaya[1], S. Watanabe[1], R. A. Budiman[1,2], K. Yashiro[1,3], T. Kawada[1]

[1]Graduate School of Environmental Studies, Tohoku University, Sendai, Japan.
[3]Research Center for Advanced Materials, National Research and Innovation Agency, South Tangerang, Banten, Indonesia
[4]Faculty of Materials for Energy, Shimane University, Matsue, Shimane, Japan

In the porous Ni(O)-YSZ hydrogen electrode of solid oxide cells (SOCs), the redox process involves significant volume changes that strongly influence the electrolyte stress. Crack formation and fracture in the electrolyte pose risks to cell performance and safety, so it is essential that these stresses are propery assessed and operated under safe conditions. Cells are typically fabricated by firing in air, which leaves them in an oxidized state, and during operation, exposure to a hydrogen atmosphere reduces the hydrogen electrode. In addition, unexpected re-oxidation can occur due to gas leaks, fuel loss or sudden shutdown. Ni has an FCC structure (a = 3.52 Å), while NiO adopts a NaCl structure (a = 4.18 Å). Taking into account the lattice constants, oxidation leads to expansion. However, when Ni and Ni-YSZ porous materials were oxidized, an unexpected shrinkage behavior was observed.[1,2].

We were motivated to reveal the origin of this phenomenon, which is probably related to differences in the diffusion rates of Ni along grain boundaries and within grains. The stresses on the electrolyte were also analyzed using the cos α method during the initial reduction and unintentional re-oxidation occurring during SOCs operation. The observed behavior was interpreted based on the basis of volume changes of the hydrogen electrode during redox cycling.

[1] F. Zhao, Master's thesis of Tohoku university, Graduate School of Environmental Studies (2017).
[2] Y. Morishita et al., ECS Trans. 91, 1979 (2019)