A three dimensional multiphysics model of a solid oxide electrochemical cell: A tool for understanding degradation

Mitigating degradation is essential for extending the lifetime of solid oxide electrochemical cells (SOCs). The conditions leading to degradation, e.g. overpotentials, gas partial pressures, thermal gradients are hard, if not impossible, to retrieve experimentally. Thus, to deconvolute the response from cell testing, modeling can be applied to understand the degradation phenomena in greater detail. Modeling of SOCs is well developed. For computational efficiency, the electrodes are often represented with a mathematical abstraction of zero thickness layer. In this work, further attention is given to the local conditions in the through-thickness of the electrodes, by rigidly integrating classical electrochemistry into a three dimensional multiphysics model of an SOC. Hereby, local conditions (e.g. overpotential) vary through the electrode, and with the coupling to the different transport phenomena occurring (mass, current, momentum and species), this becomes available in three dimensions, throughout a cell. To investigate the validity of the model, a high number of experiments are conducted at different operating conditions, i.e. in both fuel cell and electrolysis mode of operation with H₂ / H₂O as feedstock varying parameters such as temperature, gas flows and gas compositions.

General information
State: Published
Organisations: Department of Energy Conversion and Storage, Mixed Conductors, Applied Electrochemistry, Lund University
Contributors: Navasa, M., Graves, C., Skafte, T. L., Sundén, B., Frandsen, H. L.
Number of pages: 19
Pages: 11913-11931
Publication date: 2018
Peer-reviewed: Yes

Publication information
Volume: 43
Issue number: 27
ISSN (Print): 0360-3199
Ratings:
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.1 SJR 1.116 SNIP 1.267
Web of Science (2017): Impact factor 4.229
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.74 SJR 1.145 SNIP 1.315
Web of Science (2016): Impact factor 3.582
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.46 SJR 1.27 SNIP 1.314
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.54 SJR 1.207 SNIP 1.484
Web of Science (2014): Impact factor 3.313
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.38 SJR 1.265 SNIP 1.449
Web of Science (2013): Impact factor 2.93
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 3.96 SJR 1.499 SNIP 1.708
Web of Science (2012): Impact factor 3.548
ISI indexed (2012): ISI indexed yes