3-D Numerical Analysis of Solid Oxide Electrolysis Cell (SOEC) With Co-Electrolysis Operation

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Solid Oxide Electrolysis Cell (SOECs) are energy conversion system using reversible processes of Solid Oxide Fuel Cells (SOFCs) to produce H_2 by applying electricity. Due to its high operating temperature (600-1,000 □) characteristics, these can produce syn-gas (H_2 and CO) by electrolyzing H_2O and CO_2 simultaneously, and this operation mode is called as co-electrolysis mode. Because syngas can be used as a fuel for SOFC directly or can be converted to hydrocarbon fuels through a Fischer-Tropsch process, many groups research about SOEC co-electrolysis mode[1-4]. To operate SOEC co-electrolysis mode efficiently, numerical analysis is required to find main parameters of electrochemical performance.

In this research, 3-D simulation model is developed to simulate SOEC co-electrolysis mode. Electrochemical reactions (H_2O and CO_2 electrolysis reactions) are calculated in a domain of cathode triple phase boundary (TPB) layer, and chemical reactions (WGS, SR, and DSR) are calculated in a domain of cathode electrode. Developed model is validated by comparing to experimental data.

Numerical analysis of SOEC co-electrolysis is done with validated model. Cathode inlet gas composition, temperature, and cathode flow rate are considered as operating conditions related to electrochemical and chemical performance of SOEC co-electrolysis mode. To identify main parameters, various operating conditions is applied. Among many parameters, H_2O fraction of cathode inlet gas is considered as a main parameter forx electrochemical performance of SOEC co-electrolysis.

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