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Bridging the Gap Between Fundamentals and Application
Model-System Supported Impedance Simulation of Composite Electrodes

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State-of-the-art solid oxide fuel cells usually employ Ni/yttria-stabilized zirconia (Ni/YSZ) as a very well performing fuel electrode. In recent years, however, new trends in solid oxide cell development led to an again increased interest in understanding the fuel electrodes on a more fundamental level: H, S related performance losses need to be reduced to reach sufficient cell lifetimes, novel fuel electrode materials such as ceria were introduced to increase cell performance at lower temperatures, and for SOECs also novel materials are discussed to overcome the higher degradation rates of Ni/YSZ in electrolysis mode. Consequently, a knowledge based improvement of composite fuel electrodes is of great importance to tackle these issues.

Current fuel electrode research is either done on model-type pattern electrodes or by interpretation of impedance spectra measured on "real" porous paste electrodes. However, results obtained by both methods are not always straightforward to compare. A possible strategy to bridge this gap between results from model-type experiments and data obtained on entire solid oxide cells is the introduction of an intermediate level of abstraction. In the present study, this is done by simulation of impedance spectra of 3D porous composite electrodes with a well-defined geometry and the use of elementary parameters from model-type experiments. With this approach it is possible to analyse the influence of the individual elementary parameters on the overall electrode performance without the issue of changing its microstructure, which usually occurs when changing materials in case of "real" porous electrodes. The obtained results are highly valuable for identifying the most efficient way of performance improvement of porous fuel electrodes. Moreover, the developed transmission line model is used to critically discuss the common method of deconvolution of impedance data from "real" porous composite electrodes, which is often based on the assumption of elementary processes being represented by a serial connection of simple R\mid|CPE elements.