عنوان مقاله:

An investigation on effect of backbone geometric anisotropy on the performance of infiltrated SOFC electrodes

محل انتشار:

دو فصلنامه تجهیزات و سیستم های انرژی, دوره 5, شماره 3 (سال: 1396)

تعداد صفحات اصل مقاله: 14

نویسندگان:

Mehdi Tafazoli - *Mechanical Engineering Department, Babol Noshirvani University of Technology, Babol, Iran*

Mohsen Shakeri - *Mechanical Engineering Department, Babol Noshirvani University of Technology, Babol, Iran*

Majid Baniassadi - *School of Mechanical Engineering, College of Engineering, University of Tehran,Tehran, Iran*

Alireza Babaei - *School of Metallurgy and Materials Engineering, College of Engineering, University of Tehran, Iran*

خلاصه مقاله:

Design of optimal microstructures for infiltrated solid oxide fuel cell (SOFC) electrodes is a complicated process because of the multitude of the electrochemical and physical phenomena taking place in the electrodes in different temperatures, current densities and reactant flow rates. In this study, a stochastic geometric modeling method is used to create a range of digitally realized infiltrated SOFC electrode microstructures to extract their geometry-related electrochemical and physical properties. Triple Phase Boundary (TPB), active surface density of particles along with the gas transport factor is evaluated in those realized models to adapt for various infiltration strategies. Recently, additive manufacturing or freeze type casting methods enable researchers to investigate the performance of directional electrodes to get the maximum electrochemical reaction sites, gas diffusivity and ionic conductivity simultaneously. A series of directional backbones with different amount of virtually deposited electrocatalyst particles are characterized in the first step. The database of microstructural parameters (inputs) and effective geometric properties (outputs) is used to train a range neural network. A microstructure property hull is created using the best neural network model to discover the range of effective properties, their relative behaviour and optimum microstructure. The characteristics of models is shown that there is not any contradiction between the high level of TPB and contact surface density of particles, but the highest amount of gas diffusivity can be found in the microstructures with lower level of reaction sites. Also increasing the contact surface density has a negative effect on gas transport but the high level of TPB density is feasible in the full range of microstructures. In the other hand, TPB density and gas diffusion into the models are inversely related, although there are a limited number of microstructures with high level of reaction sites and acceptable gas diffusivity. Finally, using a simple optimization process, the microstructures with the highest level of reaction sites and gas transport factor are identified which have the backbone porosity of about 50%, and extremely higher gain growth rate normal to the electrolyte. Additive manufacturing and 3D printing methods will enhance researchers in the future to create the real directional electrodes on the base of these .proposed models

کلمات کلیدی:

Backbone Anisotropy, Infiltrated Electrode, Realization of Microstructure, Solid Oxide Fuel Cells