Povzetek

Delo opisuje študij priprave in karakterizacije elektrolitnega materiala na osnovi cerijevega oksida, dopiranega s samarijem (SDC) in anodnega kermeta na osnovi Ni-SDC. Materiale sem pripravljala z modificirano Pechini metodo iz raztopine kovinskih acetatov in etilenglikola.

Namen dela je bil določiti optimalne pogoje sinteze in nadaljnje obdelave omenjenih materialov. Pripravljeni končni materiali (SDC elektrolit in Ni-SDC anoda) morajo imeti primerno mikrostrukturo, hkrati pa morajo biti medsebojno kompatibilni v smislu kemijske kompatibilnosti in kompatibilnosti glede temperaturnega razteznostnega koeficienta.

Pri optimizaciji priprave sem se osredotočila na dva parametra: temperaturo kalcinacije in temperaturo sintranja. Temperatura kalcinacije vpliva na končno velikost delcev, velikost kristalitov in tudi na sinterabilnost stisnjenega prahu. Previsoka temperatura sintranja ni zaželena, saj pomeni večji ekonomski vložek v pripravo gorivnih celic v večjem merilu, na mikrostrukturnem nivoju pa se previsoka temperatura sintranja odrazi v pretirani rasti zrn.

Za elektrolitni material je ugodno, če dosežemo visoko gost material pri čim nižji temperaturi sintranja. Tako poleg ionske prevodnosti zagotavljamo tudi plinotesnost med atmosferama na anodni in katodni strani. Anodni material pa naj bi imel ustrezno poroznost (v literaturi navajajo optimalno vrednost ≈30 vol%) in kontinuiteto treh faz in sicer keramične, kovinske in por. Da na fazni meji med anodnim Ni-SDC in elektrolitom SDC med sintranjem ne nastanejo razpoke, moramo poznati sinterabilnosti obeh materialov. Razpokam se lahko izognemo s previdno izbranimi temperaturami predsintranja in kosintranja tako, da uravnamo skrčke obeh materialov.

V pričujočem delu je opisana tudi konstrukcija ter modeliranje testne celice. Pri modeliranju delovanja testne celice je poseben poudarek na vplivu temperaturnih gradientov na ustvarjene napetosti v materialu, ki so posledica točkovnega gretja sistema. Študirala sem tudi vpliv hitrosti segrevanja na verjetnost odpovedi materiala zaradi razslojevanja.

*Ključne besede: SOFC, cerijev oksid, NiO-SDC, večplastni sistem, modeliranje*

Abstract

This work describes the preparation and characterization studies of electrolyte material based on cerium oxide doped with samarium oxide (SDC) and anode cermet based on (Ni-SDC). Materials were prepared by a modified Pechini method from a solution of metal acetates and ethylene glycol.

The aim of the present work was to optimize the synthesis conditions and subsequent treatment of the prepared materials and should exhibit an appropriate microstructure and temperature expansion coefficients which should be compatible with each other. When optimizing the materials preparation two parameters were described in details: temperature of calcination and sintering temperature. Calcination temperature influences the final particle size, crystallite size and also sinterability of compressed powders. Sintering temperature exceeding optimal value is not desirable because it means greater economic input into the preparation of fuel cells when scaling up. While on the microstructure level it results in pronounced grain growth.

It is of high importance for the electrolyte material that it achieves high density at lowest possible sintering temperature. High density provides the gas tightness between the anode and cathode compartments. The anode material on the other hand should have an appropriate porosity (optimal porosyty is in the literature indicated as ≈30 vol%), the continuity of all three phases: the ceramic, the metal and the pore. The cracks at the interface between Ni-SDC anode and SDC electrolyte could be avoided by knowing the sinterability properties of both materials. With carefully selected temperatures of presintering and cosintering temperatures could adjust the shrinkage of both materials.

In this work the construction and modeling of the testing cell was also described. With modeling, the influence of temperature gradients which creates tension inside the tested membrane and are a consequence of heating point is particularly pronounced. The failure probability of materials due to delamination as a consequence of rapid heating rate of the testing system is also addressed.

*Key words: SOFC, CeO2, NiO-SDC, multilayer system, modelling*