HYBRID MATERIALS DESIGN FOR SOFC INTERCONNECT APPLICATIONS

By

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ABSTRACT

Solid oxide fuel cells (SOFCs) offer distinct advantages when compared with alternative energy conversion techniques; however, problems with degradation, particularly interconnect degradation, are currently hindering adoption. One potential solution to mimimize interconnect degradation is the use of novel hybrid materials which leverage the composite properties of well characterized, commercially available materials to create a new superior material.

A model hybrid material has been developed based on functional laminate construction. A corrosion resistant Ni-200 layer was roll clad onto an inexpensive, low CTE 430 SS Core material. Finally, a conductivity boosting manganese cobalt spinel coating was applied using wet powder spray to the surface. This model material allows us to explore the orthogonal nature of different interconnect functions and their related properties and performance by utilizing our comprehensive screening procedure.

Utilizing a factorial design experiment, the effects of simulated SOFC conditions on a model material was investigated through a series of tests. Oxide structure and morphology were investigated using XRD and SEM analysis, respectively, followed by high temperature conductivity testing. Cross sectional composition analysis was performed utilizing AES and optical microscopy evaluated using reflected light optical microscopy. Finally, elevated tensile testing and dilatometry provided mechanical data throughout the temperature range of interest. This broad screening process allows us to elucidate previously unknown connections between materials properties, operational parameters, and system performance.

Interconnect resistance was demonstrated to be chiefly a function of surface resistance, more specifically surface chemistry, and operation temperature reductions could cause order of magnitude increases in resistance. Corrosion resistance, as expected, proved to be most closely dependent on laminate composition, although

surface chemistry did affect oxidation rate. Surprisingly, thermal expansion was equally a function of laminate composition and surface oxidation rate. Ideally, the conclusions and design recommendations provided by this work will enable a new approach to functional design hybrid material interconnects.