College of Engineering

TENNESSEE TECH

The Department of

Mechanical Engineering

Announces the Thesis Defense

of

David Chesson

In Partial Fulfillment of the Requirements

For the degree of

Doctor of Philosophy in Engineering

April 9, 2021

2:00 p.m.

Tennessee Tech University

Zoom Link: https://tntech.zoom.us/j/3132969781

FIELD OF STUDY

Mechanical Engineering

DISSERTATION TOPIC

Effect of Off-Stoichiometry on Electrical Conductivity in Ni-Fe and Mn-Co Spinel Systems for Solid Oxide Fuel Cell Interconnect Coating and Contact Layer Applications

EXAMINING COMMITTEE

Dr. Jiahong Zhu (Chairperson)

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ABSTRACT

The optimization of cathode-side interconnect coating and contact layer materials is critical to the long-term performance durability and successful commercialization of solid oxide fuel cells (SOFCs). Transition metal spinels have found widespread use as protective materials for ferritic stainless-steel interconnects. This study focuses on the synthesis and characterization of off-stoichiometric NixFe3-xO4 and MnxCo3-xO4 spinels with the goal of identifying optimal compositions in both systems for SOFC interconnect and contact coating applications.

Bulk NixFe3-xO4 and MnxCo3-xO4 were obtained via the solid-state reaction. The effect of off-stoichiometry on electrical conductivity and the coefficient of thermal expansion (CTE) were investigated. The conductivity of NixFe3-xO4 spinels was found to exhibit a drastic increase with increasing Fe content, while the CTE was observed to be relatively insensitive to compositional variation. Both the electrical conductivity and CTE of MnxCo3-xO4 spinels were observed to increase with increasing Co content. Based on these results, optimal compositions were identified for both spinel systems.

The effect of off-stoichiometry on the high-temperature diffusion between MnxCo3-xO4 and Cr2O3 was also determined. The parabolic rate constant for the reaction layer formation was found to increase with increasing Mn content. A range of optimal compositions was determined based on the projected area specific resistance and CTE match.

Based on the measured structural, electrical, and thermal properties, cationic distributions were proposed and compared to previous results for both spinel systems.

BIOGRAPHICAL SKETCH

David Chesson was born in Raleigh, North Carolina and raised in Murfreesboro, Tennessee. He began studying Mechanical Engineering at Tennessee Technological University (Tech) in 2011 was granted his B.S. in Mechanical Engineering in May 2015. While attending Tech as an undergraduate, he was inducted into the Tau Beta Pi engineering honors society and worked as an undergraduate researcher under his future doctoral advisor, Dr. Jiahong Zhu. In June of 2015, David began his graduate research and coursework related to material science, where his work primarily focused on solid oxide fuel cell

EDUCATION

Ph.D. Engineering
Tennessee Tech University, 2015-2021 (anticipated)

B.S. Mechanical Engineering
Tennessee Tech University, 2011-2015

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