

Miss Nikkia McDonald B.S., M.S.

Doctoral Researcher

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About

Nikkia joined the Hydrogen Energy & Fuel Cell Group in Fall term 2011 as a doctoral researcher. She is a native of Chicago, IL and received her M.S. degree in Materials Science and Engineering from Northwestern University under the supervision of Scott A. Barnett. Prior to earning her M.S. degree, Nikkia graduated with a B.S. degree in Chemistry from the University of Illinois – Urbana, Champaign.

Nikkia's PhD research, carried out under the supervision of her advisor Dr. Robert Steinberger-Wilkins, aims to demonstrate direct methane Solid Oxide Fuel Cell (SOFC) operation by developing new Ni-based Zirconia anodes that suppress carbon formation and are stable against sulphur impurities without sacrificing cell performance.

The research will be divided into three phases: materials characterization and selection, cell preparation and testing and cell analysis, optimization and standardization.

Qualifications

M.S. – Materials Science and Engineering
B.S. – Chemistry

Biography

Nikkia moved to the UK in the fall of 2011 to enrol in the Chemical Engineering PhD program at The University of Birmingham. Prior to her arrival in Birmingham, Nikkia was a research scientist for a small company located in a northern suburb of Chicago and she was responsible for the fabrication, testing and optimization of SOFC in series stacks under hydrogen and direct methane operation. She led several materials development projects and contributed her knowledge in the areas of fuel cell fabrication and testing.

Research

Solid Oxide Fuel Cell (SOFC) systems operate at temperatures 500 – 950°C and have garnered interest in recent years due to their higher conversion efficiencies when compared to heat engines, variable fuel capability, low noise operation and cell design flexibility. While these advantages make SOFCs one of the most sought after technologies, the technical challenges associated with high temperature operation and the issues with the utilization of hydrocarbon fuels currently create economic barriers for widespread implementation. Developing SOFC systems for direct hydrocarbon utilization in intermediate temperature regimes allows immediate use of fossil fuels, eliminates the need for separate fuel reformers and purification systems and allows by-product heat to be recycled back into the cell stack or used in a cogeneration heat and power application. This also improves system stability and reduces degradation offering major cost benefits and promoting an ever increasing interest in SOFC commercialization, solidifying their position in the new energy economy.

In this work, lab scale single cell SOFCs containing doped Ni-ScSZ anodes will be examined to measure their appropriateness for hydrocarbon operation. Likewise, the influence of alloying other elements into the nickel will be studied, for instance iron, vanadium, silver or copper. These systems will be investigated to determine their methane reforming ability, measure their electro-catalytic activity, examine their efficiency to suppress coking and study their tolerance for sulphur impurities. Preliminary work will be carried out on Ni-YSZ/YSZ anode supported button cells to be used as baseline comparisons followed by cells containing doped Ni within a 1mol% Ceria (CeO₂) -10 mol% Scandia (Sc₂O₃) Stabilized Zirconia (10Sc1CeSZ) matrix. The 1mol% CeO₂ serves as a mixed conductor and oxidation catalyst for the hydrocarbon fuel. ScSZ will be the electrolyte of choice to lower operating temperature and improve O²⁻ transport to the anode. Characterization of the anode powders will be carried out via X-Ray Diffraction, BET and SEM. Particle size, anode shrinkage, porosity, cell microstructure, substrate roughness, layer-interfacial composition, cell performance and electrode resistance will be examined using a particle size analyzer, dilatometer, Archimedes' method, cross-sectional SEM, interferometry, EDS, I-V measurements and IS spectra.

Other activities

A little over a year into her PhD research, Nikkia has presented posters and attended workshop events within the UK and Europe. Her training includes:

I-DRAC Meeting – University of Birmingham
MEGS Inaugural Lecture – University of Nottingham
8th Annual Hydrogen Fuel Cell Conference – NEC Convention Center (poster)
Fuel Cell School – Kyiv Polytechnic
UOB Graduate School Research Poster Conference – University of Birmingham (poster)
10th European SOFC Forum – Lucerne, Switzerland (poster)
MEGS Sustainable Energy Training Workshop – University of Birmingham
Climate KiC-PIP International Placement – Valencia, Spain
Network of Energy Centres DTC Training Conference (display demo) – University of Manchester

Also:

Manned table and answered questions related to fuel cell technology at University of Birmingham Open Day.

Carried out fuel cell talks and demonstrations at University of Birmingham Community Day.

Talked with middle school students about hydrogen energy and fuel cells and created fun, interactive group activities for students as part of engineering school public

