Solid Oxide Fuel Cell Visual Recognition of Images to Show 3d Printed Part Effectiveness.

New Mexico Supercomputing Challenge

Final Report

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Team 24

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Executive Summary

Fuel cells have long been used as an alternative to battery power. Fuel cells are seen as a more efficient alternative to battery power for some larger projects. Because of this, experiments are constantly being conducted to research and improve fuel cells. One such fuel cell being tested is known as a Solid Oxide Fuel Cell. However, problems have slowed down researchers and the testing process overall.

During the testing for the fuel cells a mesh is applied to the button cell part of the fuel cell. This mesh is applied on a bed of electrolytic paste. This part is integral to the testing process and must be as exact as possible. However the electrolytic paste is currently applied by hand and this leads to inconsistencies in the surface area and thickness of the paste applied. This leads to inaccurate results.

Currently the testing process has hit a wall due to issues such as these. The cost of the wasted electrolytic paste makes the testing very expensive. On top of this each test takes a lot of time to complete. Because of the cost of time and money during the testing process, very few experiments can take place during a testing cycle. This makes removing any inconsistencies very important.

The current plan is to 3-d print a model template that can be used to apply a consistent amount of paste. This will not only speed up the testing process, but will also save time and money. This will all help to make the volume of the paste more accurate

overall. This will lead to the Improvement of Solid Oxide Fuel Cells. It will also save large amounts of time and money.

Introduction

The project

Use a 3d printer to print a template to apply a consistent amount of electrolytic paste during experiments with electrolytic paste.

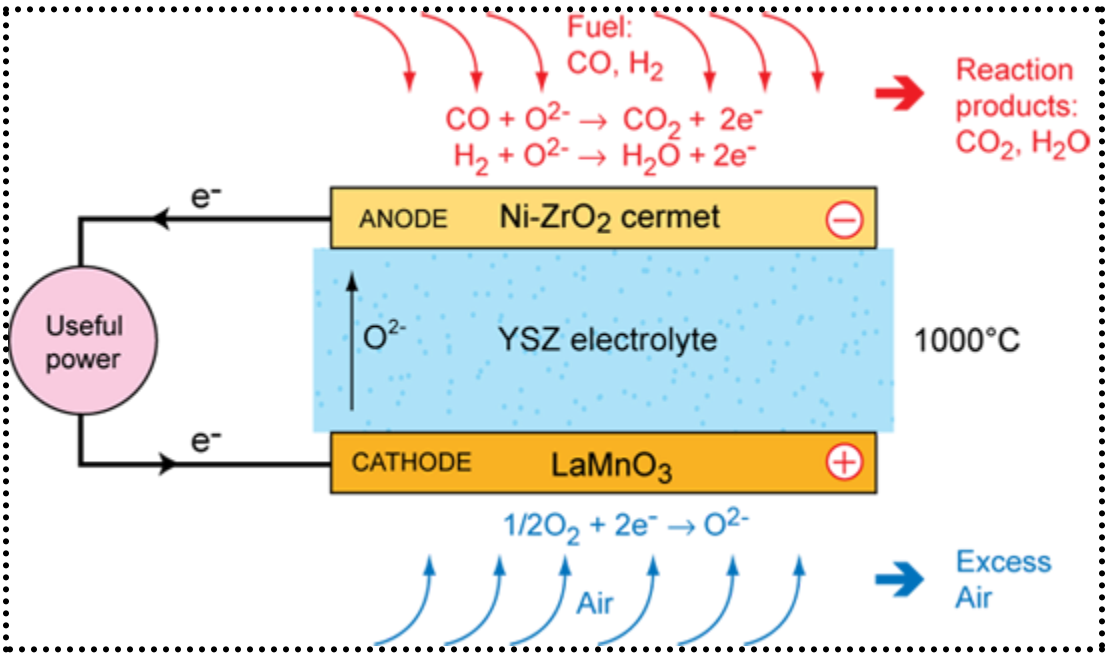
Fuel Cells

Fuel cells are a type of energy device which generates electricity through a chemical reaction. They are seen as a more efficient way to produce electricity in the long term, because as long as they have a fuel source they can run almost indefinitely. They are used as a long term energy source for space shuttles and satellites. This makes improving their effectiveness important to many projects overall.

Some of the different types of fuel cells include. Methanol fuel cells, alkaline fuel cells, and phosphoric acid fuel cells. While the basic concept remains basically the same across the fuel cells, electrochemical reaction to electricity, there are also many differences. Most fuel cells use different types of fuel sources to fuel their reactions. This leads to different fuel cells being better for different purposes. Solid oxide Fuel Cells for example use Hydrogen and Oxygen to fuel its chemical reaction.

Solid Oxide Fuel Cells operate by converting the energy from a chemical reaction into usable electricity. Inside a Solid Oxide Fuel Cell the electrolyte, or button cell, is placed between two electrodes. The two things that fuel the electrochemical reactions are Hydrogen and Oxygen. Hydrogen is entered into the anode side of the cell, while oxygen is entered into the cathode side of the cell. These interact inside the electrolyte and the byproducts are water, depleted oxygen and hydrogen, and electricity.

Solid Oxide Fuel Cell ElectroChemical Reaction.



Fuel Sources

While most fuel cells use pure hydrogen as a fuel source, solid oxide fuel cells use hydrocarbon fuels such as natural gasses to get its hydrogen. This is helpful for certain things such as the Apollo mission where these were in abundance on the spacecraft to use as a fuel source. On top of this the waste product of water made in enticing to use on the spacecraft. These have all led to the US government having an interest in Solid Oxide Fuel Cells. This makes researching them very important to all future projects.

The other source of fuel used in these fuel cells is oxygen. The oxygen is important to the electrochemical process that takes place to generate the electricity. This is useful as oxygen is also usually an abundant resource available to be used as fuel. The reaction in this process leads to the electrical charge. The fuel sources and reaction is simple enough to justify using these solid oxide fuel cells.

Air Force Research Lab

The Air Force Research Lab is a research wing of the United States Air Force. They run experiments on a whole host of STEM projects. They have been running experiments with solid oxide fuel cells and have run into problems with the experimentation process. This has led to time and money being lost, as well as any possible advancements that may have been made. The experiments on the solid oxide fuel cells have been to make them more efficient overall. However they have been unsuccessful in obtaining accurate results

During an experimentation process everything must be as similar as possible to ensure the accuracy of the data. The experimentation on fuel cells is no different in the sense that multiple are being experimented on at a time. During the experiments a mesh is applied to the button part of the cell via a bed of electrolytic paste. The paste is only supposed to cover just enough of the button cell to stick the mesh on. However due to it being applied by hand, variations can occur in the paste and this leads to inconsistencies across the data.

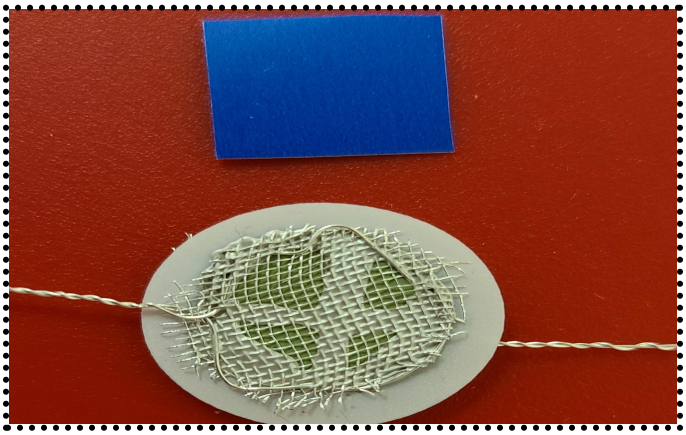
When the paste is applied by hand, variations in the thickness, width, and overall surface area of the paste varies button cell to button cell. This means that any data received has inaccuracies that must be taken into account. This leads to wasted time and money as the electrolytic paste used in the experiments is very expensive. Very few button cells are tested during a research cycle which also leads to wasted time. This however could be solved with a template for applying the paste.

The Template

The idea for the template is a 3d printed design that can be set on the button cell to apply the paste. The size of the template should be slightly smaller than a dime. This template can be used to apply a more consistent amount of the paste to the button cell each time. All a researcher would need to do is fill in the empty parts of the template with the electrolytic paste. This would lead to more consistent and accurate results.

The Software

The program is a Netlogo based software that is able to take an image of the fuel cell



with the mesh and compare it to a same sized piece of tape. It counts the pixels covered or not covered by the paste and compares it to the pixels on the tape. Using this data you can receive a measurement of how accurate the paste has made the results.

The Results

All results will be further tested in the advanced material lab. The results will be tested by Dr. John Plumley.

Citations

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