High Performance Proton Conductor Solid Oxide Fuel Cell Based on BSCZGY

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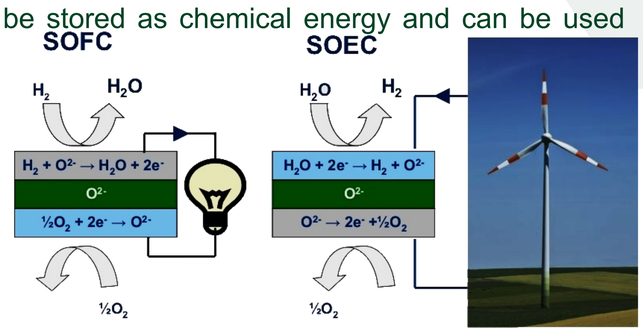
BACKGROUND

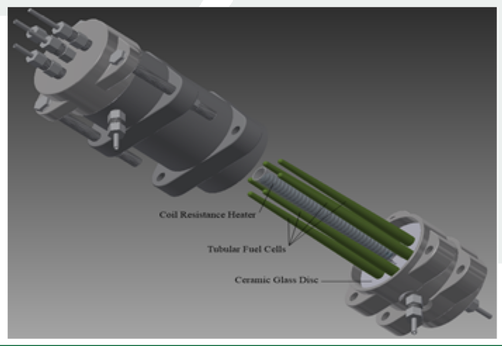
- Solid Oxide Fuel Cells (SOFC) produces electricity directly from oxidizing a fuel.
- Solid Oxide Electrolysis Cells (SOEC) is solid oxide fuel cell set in regenerative mode.
- SOECs are very efficient compared with other electrolysis methods as they produce more oxygen and carbon monoxide from a given amount of electricity.
- Surplus electricity production can be stored as chemical energy and can be used whenever needed.
- It is essential to have a high performance SOEC to convert the chemical energy to electrical energy with the highest efficiency as possible.

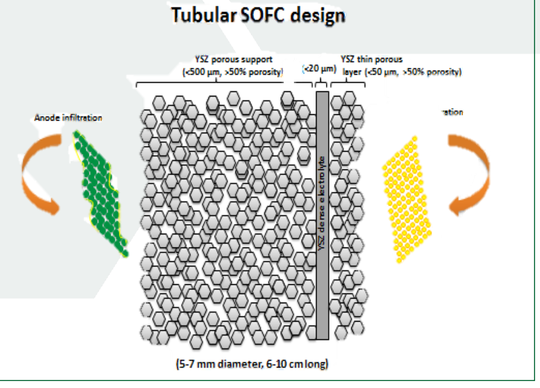


$$H_2 + CO + O_2 \underset{\text{SOEC}}{\overset{\text{SOFC}}{\rightleftharpoons}} H_2O + CO_2 + \text{electric energy } (\Delta G) + \text{heat } (T\Delta S)$$

AIMS AND OBJECTIVES

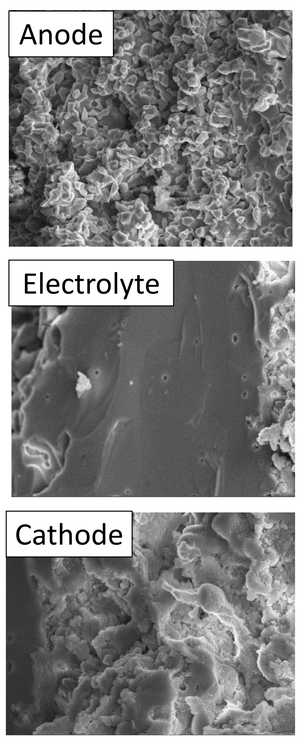
- A proton-conductor SOFC is very promising for SOEC, can run without diluting the fuel and has lower operating temperature
- Problem of poor chemical stability in the presence of moisture and CO_2
- $Ba_{0.5}Sr_{0.5}Ce_{0.6}Zr_{0.2}Gd_{0.1}Y_{0.1}O_{3-\delta}$ is a proton conductor without the stability problem under moisture and CO2
- We aim to use this electrolyte and fabricate a complete cell and run it as both SOFC and SOEC

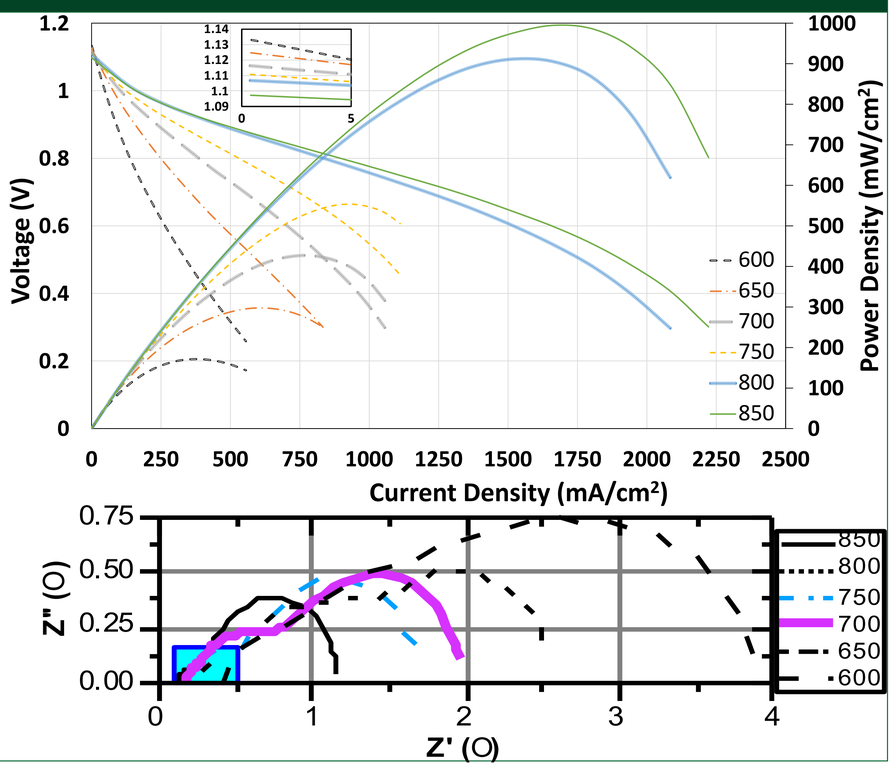




RESULTS

- The electrochemical examination under air/H_2 + 3 vol. % H_2O showed superior performance achieving a maximum of 1 W/cm2 at 850 °C, one of the highest power reported so far on tubular proton conductor SOFCs.
- The conductivity of electrolyte seen slight changes above 800 °C.
- Impedance analysis revealed the major part of resistance comes from polarization, dominated by bulk diffusion, which is the bottleneck of performance and makes it essential to optimize the cell microstructure.
- The micrograph also confirms this understanding. Satisfactory long-term results seen for 4 days run under load and impedance confirms this result.
- This intermediate temperature - SFOC based on BSCZGY would be a suitable candidate for practical applications, especially in power generation and solid membrane reactors.





FUTURE DIRECTIONS

- In the future, we will continue the development and implementation of this high performance electrolyte in a SOEC reactor.
- Effect of fuel utilization, fuel impurities, especially a high concentration of carbon dioxide and steam will be evaluated.
- Diagnosis of long-term degradation of output especially under hydrocarbon fuels will be studied. It is essential to make sure no coke formation or unwanted reactions between cell components happen during the long run.
- To facilitate better understanding of the system's performance parameters and their impact on the long-term run, we will also study microstructure parameters.

PARTNERS

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Development of new electrode materials, high performance tubular SOECs
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FES PROJECT OVERVIEW

T06-P04
The main objective of the utility-scale energy storage project is to develop energy storage solutions that are suitable for storing energy in the MWh range and provide MWs of power to the grid at competitive costs. Research will mainly focus on the development of technologies for hydrogen production for storage.
The anticipated outcomes for this project will be the development new technologies for hydrogen production that exhibit lower capital cost, and higher efficiency and durability, the production of high impact research through internal and international collaborations, and the development of strong partnerships with industry where UAlberta will be playing a central role in research and development.

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