UTILITY-SCALE ENERGY STORAGE: HIGH-TEMPERATURE ELECTROLYSIS

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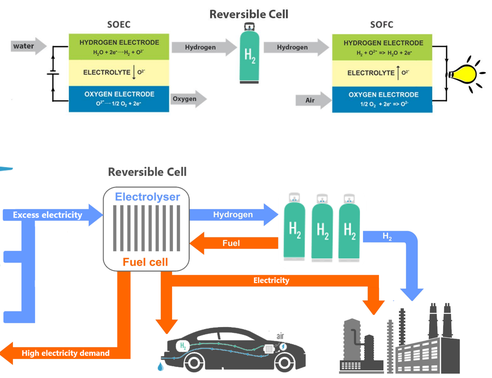
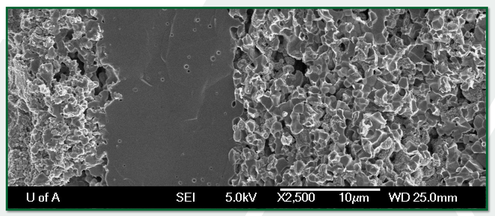
BACKGROUND

- Solid Oxide Fuel Cells (SOFC) generates electricity by oxidizing a fuel (e.g. Hydrogen) at high temperatures
- Solid Oxide Electrolysis Cells (SOEC) use electricity to split water molecules into hydrogen and oxygen.
- A reversible Cell can use excess electricity (e.g. produced by wind turbines or in the electrical grid) to store hydrogen (SOEC) AND produce electricity by using the stored hydrogen at high electricity demand (SOFC)



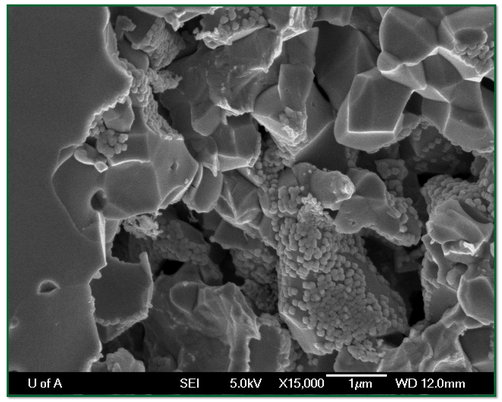
SHORT-TERM OBJECTIVES

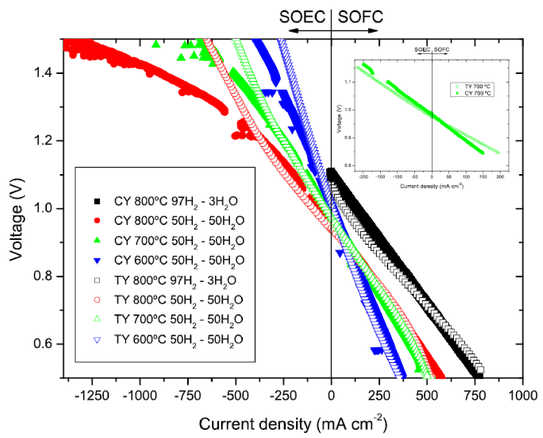
- Studying the effect of electrode microstructure on the performance of SOECs and optimizing the microstructure of bifunctional electrodes for reversible SOFC/SOECs
- Investigating the activity and durability of the NBCaCF catalyst for the oxygen evolution reaction and decreasing the operation temperature by using novel electrode preparation methods
- Studying the novel and improved SOFC electrode materials, e.g., Nd_2NiO_4, under SOEC mode
- Evaluating a novel design for the inner current collector to improve the stability of tubular cells
- Planting catalytically active nano-particles on functional electrode scaffolds using in-situ ex-solution on non-stoichiometric perovskite



PROJECT OVERVIEW

- **Microstructural optimization**
  The microstructure of the electrodes must be optimized to withstand the operational variations (differences in polarization, fuel composition and electrochemical reactions) in SOFC/SOEC modes.
- **Catalyst utilization**
  Utilization of the novel catalysts and studying their behavior under SOEC mode which is critical for increasing the reaction rate and decreasing the operation temperature.
- **Degradation mechanism**
  The fundamental understanding of degradation mechanism in SOEC/SOFC modes will be achieved for further improvement of the cell in reversible mode.
- **Long-term operation condition**
  Optimizing the microstructure and applying novel catalysts can limit the microstructural changes, decrease the operation temperature and improve the longer term stability.
- **Fabrication of an SOEC stack**
  A stack of multiple cells will be developed to investigate the effect of stacking on performance of SOEC cells.





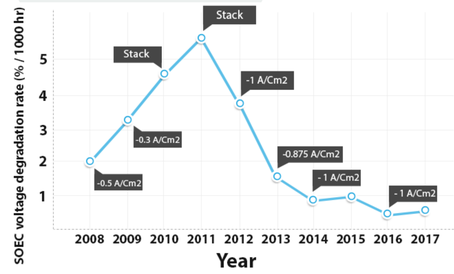
THEME OVERVIEW

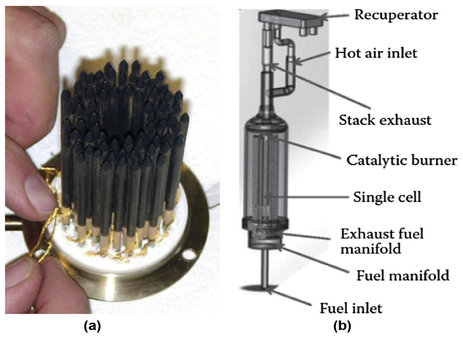
Grids and Storage

New technologies enable us to exploit renewable energy resources, but truly harnessing their energy requires the ability to control and adapt to the complex interaction between multiple sources and users. Smart grid technology will enable systems that can adapt to the variation in supply that is common from renewable sources, while new storage technologies will make it possible to retain energy generated at during peak times to be withheld for later use. Developing hybrid grids that can accommodate both AC and DC power, accommodating distributed generation, and effectively interfacing with legacy grid systems will be essential to our energy future.

EXPECTED OUTCOMES

- Maximizing the efficiency of SOECs by considering the influence of electrode microstructure on polarization losses and the required heat balance (Joule heat vs. enthalpy requirements)
- Increasing the efficiency of the cell by using novel catalysts in SOEC mode
- Developing an understanding of previously proposed performance degradation mechanisms in both SOFC and particularly SOEC modes
- Scaling up an SOEC device to a multiple cell stack





EXTERNAL PARTNERS

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