

MATERIALS

ELECTROLYTE AND FULL MATERIALS SETS

OVERVIEW

There has been significant recent advancements in SOFC materials set development for use in reversible applications [1,2,3]

- means of optimizing electrode performance
- expected degradation rates in fuel cell and electrolysis modes
- manufacturing process impacts on reversible SOFC performance.

We use wet-chemical-route fabrication and composition optimization of electrode and electrolyte materials;

We manufacture planar anode-supported SOFC button cells (1" diameter) using tape-casting, screen-printing, and co-firing processes;

We test planar anode-supported button cell (1" diameter) reversible SOFCs;

We are initially focused on LSGM-based electrolyte materials investigation

Strontium- and magnesium-doped lanthanum gallate (LSGM: $\text{La}_{1-x}\text{Sr}_x\text{Ga}_{1-y}\text{Mg}_y\text{O}_{3-\delta}$ [4,5,6,7] perovskite-type compound one of the most promising candidate SOFC electrolyte materials high oxygen ionic conductivity (0.17 S/cm) at 800°C, which is comparable to that of YSZ at 1000°C excellent stability over a broad range of oxygen partial pressure from 1 to 10^{-22} atm

GOALS AND OBJECTIVES

Overall Goal:

Manufacture and test intermediate-temperature reversible SOFCs based on a novel materials set for applications in renewable energy systems.

Objectives:

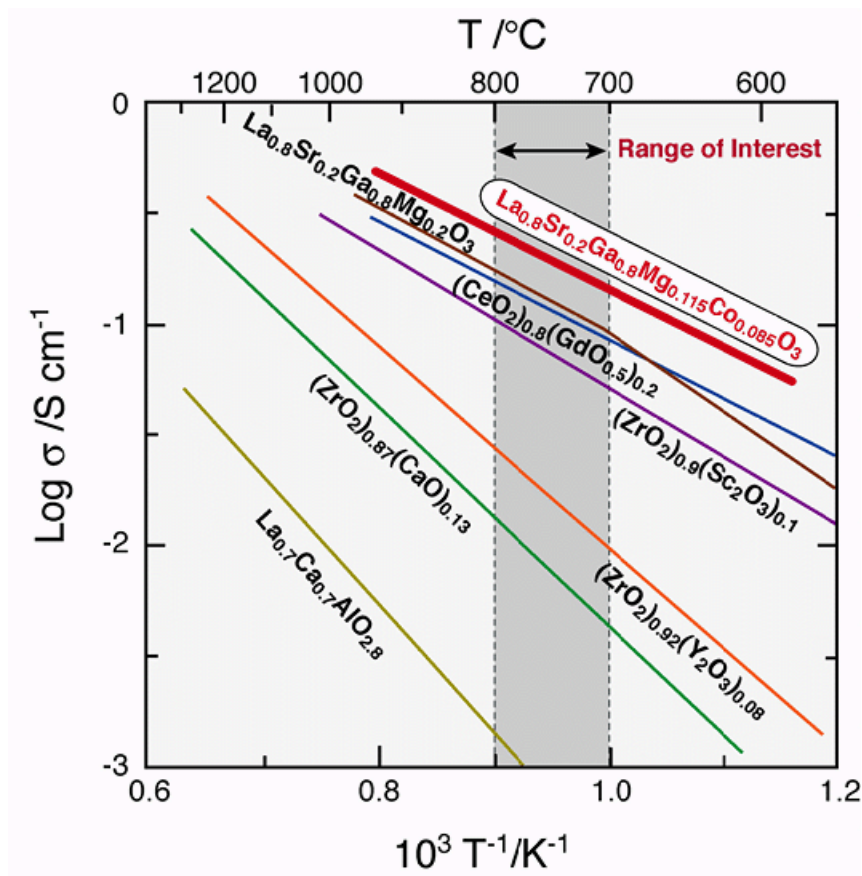
Address the primary shortcomings and challenges that have plagued recent reversible SOFC technology by:

- Developing a novel set of intermediate-temperature reversible SOFC materials designed for use in dual modes
- Manufacturing planar anode-supported 1" button cell reversible SOFCs
- Testing planar anode-supported 1" button cell reversible SOFCs for future scale-up projects
- Determining the feasibility of product commercialization.



BACKGROUND

Typical electrolyte performance comparison as a function of temperature

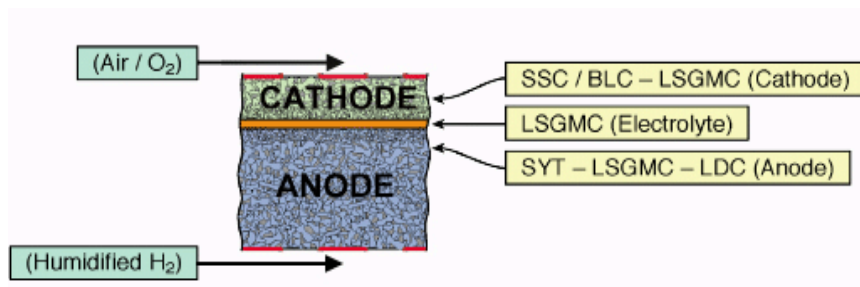


APPROACH

Dopant levels of Sr, Mg, Co at the A-site and B-site that will be investigated in the LSGMC materials set.

	La _{0.8} Sr _{0.2} Ga _{0.8}				La _{0.9} Sr _{0.1} Ga _{0.8}			
Mg	0.1	0.115	0.15	0.2	0.1	0.115	0.15	0.2
Co	0.1	0.085	0.05	0	0.1	0.085	0.05	0

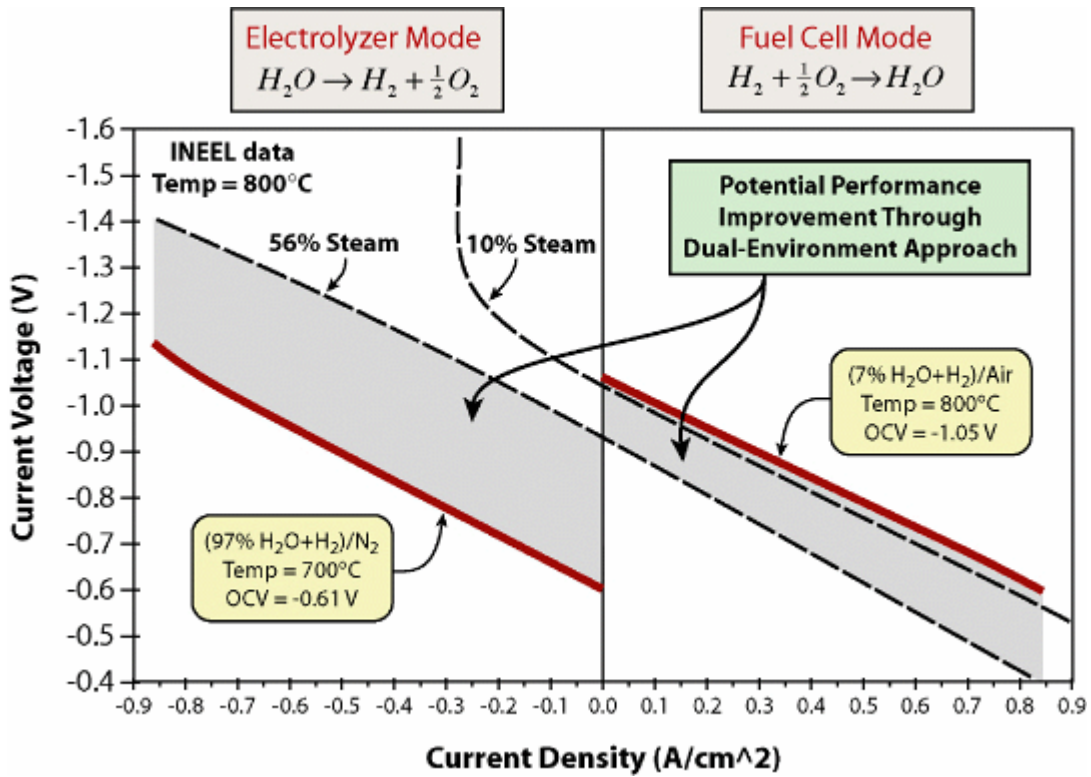
Schematic of a novel materials set for intermediate temperature reversible SOFC – Anode supported button cells manufactured by tape casting, screen printing and co-firing processes



Current phase includes electrolyte and electrode manufacturing/testing

Next phase may include larger cells, interconnect, surface engineering, etc

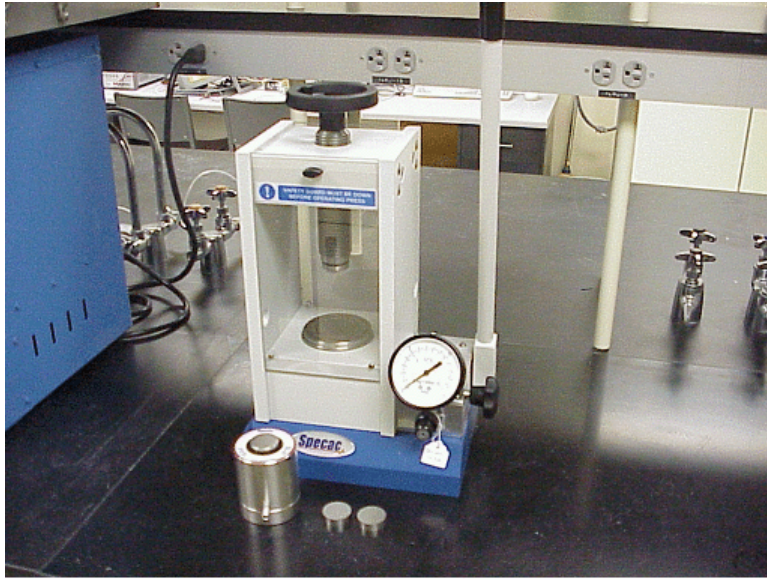
Performance improvement expected by a novel mode-dependent operating strategy



Expected operating conditions to be investigated

Fuel Cell Mode			Electrolyzer Mode		
T (°C)	P _{H2O} (atm)	P _{H2} (atm)	T (°C)	P _{H2O} (atm)	P _{H2} (atm)
700	0.03	0.97	700	0.03	0.97
	0.10	0.90		0.10	0.90
	0.30	0.70		0.30	0.70
	0.50	0.50		0.50	0.50
800	0.03	0.97	800	0.03	0.97
	0.10	0.90		0.10	0.90
	0.30	0.70		0.30	0.70
	0.50	0.50		0.50	0.50
800	0.03	0.97	700	1	0
	0.03	0.97		0.99	0.01
	0.03	0.97		0.97	0.03
	0.10	0.90		0.90	0.10

Manual hydraulic press and 1-1/4" evacuable pellet die for making button cells



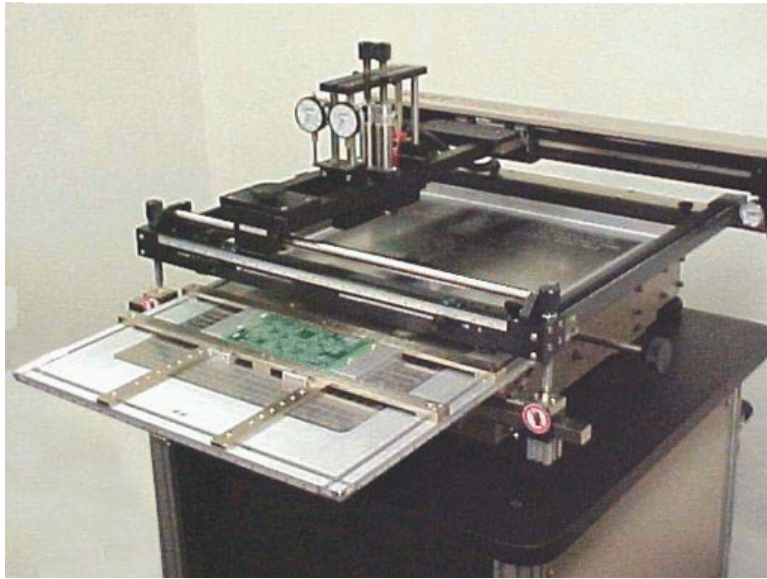
MHI high temperature (1700°C) sintering furnace and Paragon calcination kiln



HED Lab-Cast™ 7 foot tape caster



Screen printer for fuel cell manufacturing – thin electrolyte layers and electrodes



ATS single zone multi-sample split tube test furnace



Solartron models 1260 and 1480 8-Channel Electrochemical Testing Equipment



PERSONNEL

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