CONCEPT PAPER

for KIER International Cooperation project

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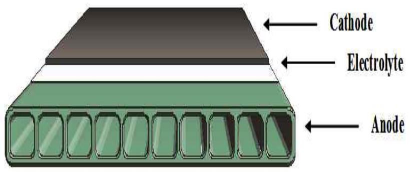
Title

Design and analysis of an optimal solid oxide fuel cell stack structure on anode for internal reforming in a flat tubular supported cell

Description

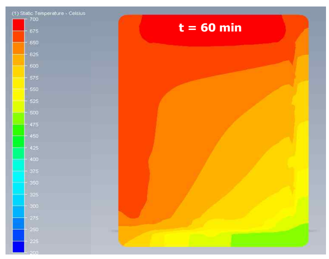
● Barrier(s) to tackle



1. For SOFCs to be successfully commercialized, the path to volume production and cell performance with a high durability and low cost must be clearly understood and developed.
2. Tubular SOFCs have simpler sealing and manifolding configurations than planar cells, but volumetric and gravimetric densities are limited for higher power systems.

● Strategy to solve

1. The first approach is focused on an anode supported flat-tubular cell approach to combine the high power density of a planar cell with the simplified manifolding, interconnection and sealing characteristics of a tubular geometry. The proposed design uses an extrusion process to manufacture the anode support that serves as the mechanical support for the thin film electrolyte and electrode structure. Secondary functions of this structure include fuel and off gas management and current collection. The simple gas diffusion path provided by the channels will reduce the impact of steam formation and diffusion, and prevent this phenomenon from limiting stack performance at high power density.
2. The structure will be completely encapsulated by dense electrolyte produced by a proved low cost aerosol deposition process thus removing the need for seal materials that are in proximity to the electrochemically active cell components.
3. The anode electrode will be approximately 500 microns in thickness and the permeability of this layer can be tailored using appropriate organic pore-formers during processing. This will allow the structure to operate at high current (power) density without suffering steam diffusion limitation.
4. Due to the very thin (15 microns) and ionically conductive electrolyte coupled with a highly permeable anode, the expected temperature of operation is approximately 750°C thus allowing low cost cathodic current collection.
5. Anode current collection will be facilitated by lateral conductivity through the anode structure including the non-active vertical support struts of the extrusion.
6. The anode inlet and off gas collection will be made via dual purpose brazed joints that will serve as electrical contact and seal joints to the anode support.
7. CFD modeling also will be conducted to gauge sensitivity of flow distribution, cell performance, temperature gradients, effects of catalysts on flat tubular supported component variables, such as seal thickness, current collector foam density, interconnect thickness and channel dimensions. The sensitivity analysis will be used as a basis to set the limits for manufacturing tolerances on the stack components.



Outcomes*

● Efficiency 55% (current 50%), SOFC stack cost down (100 units volume, 590 $/kW to 473 $/kW), CO_2 emission abatement 13%

● Publications and/or Patents

- Number of publication (SCI article with IF upper 20%): 2
- Technology Transfer: 1, Patent applying: 1