Ceramic Anode-Supported Solid Oxide Fuel Cells with High Performance and Tolerances towards Carbon Deposition and Sulfur Poisoning

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Fuel cell electrical efficiency, defined as: \( \eta = \frac{\Delta G}{\Delta H} \)

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Collaborators:
China University of Mining & Technology, Beijing: M. Han—Freeze casting, sintering aids
University of South Carolina: K. Reifsnider & P. Majumdar—Multiphysics, 3D tomography
Oak Ridge National Laboratory: In-situ neutron diffraction
Brookhaven National Laboratory: X-ray absorption fine structure (XAFS)

Reforming by partial oxidation: \( \text{C}_4\text{H}_{10} + 2\text{O}_2 = 4\text{CO} + 5\text{H}_2 \)
\( \Delta H (\text{kJ/mol}) \) \( \Delta G (\text{kJ/mol}) \) \( \eta(\%) \) \# e
1. \( -2,660 \) \( -2,810 \) 106 26
2. \( -2,370 \) \( -1,760 \) 74 18

Direct oxidation: \( C_4H_{10} + 6\frac{1}{2}O_2 = 4CO_2 + 5H_2O \)

After reforming: \( 4CO + 5H_2 + 4\frac{1}{2}O_2 = 4CO_2 + 5H_2O \)

In situ techniques:

Chemical reaction:

\[ J_i = -nF D_{H_2} \frac{e}{r} \left( C_0 - C_{H_2} / \delta \right) \]