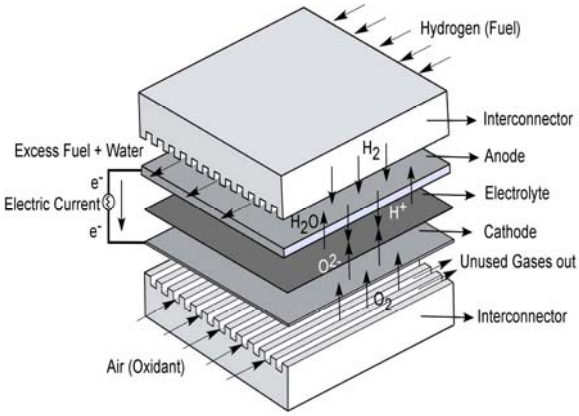
Water & Thermal Management and Optimization of PEMFCs/SOFCs

S.Y. Son and R.M. Manglik (MINE):

Objectives: The primary objective of this thrust area is to address thermal and water management needs of PEMFCs and SOFCs, and their consequent miniaturization and optimization.



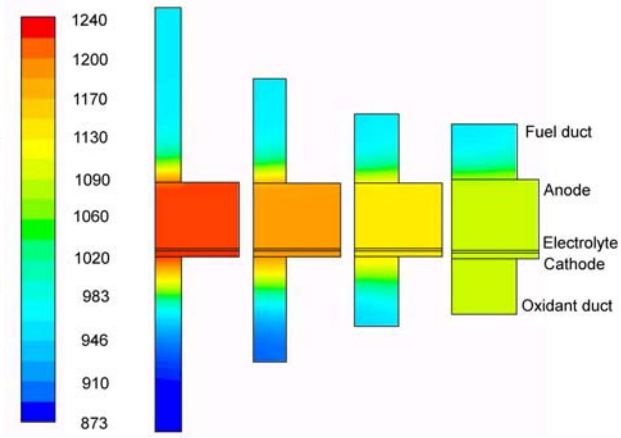


Fig. 4 . Components of a SOFC.

Fig. 5. Lateral temperature profile in a SOFC

Approach: Fuel Cells have become increasingly attractive as they can readily operate on fuels such as hydrogen and organic hydrocarbons. However, their system optimization is critically important for their viable usage and enhancement of energy efficiency and power density. Primary determinants for this are thermal and water management to control and enhance the heat, mass and volatile species transport. Their optimization requires experimentation and computational modeling that address micro-channel forced convective heat/mass transfer, two-phase flows, and interfacial phenomena, along with micro-fabrication techniques. The electrochemical optimization of these fuel cells and minimization of their structural footprint requires concerted study and research in the following areas:

- Water management with micro-channel two-phase flow and heat transfer; CO_2 and water separation; GDL and GSC design **(Years 1 – 2)**.
- Thermal management via convective heat, mass, and species transport through interconnect micro-channels and porous anode/ cathode layers; passive and hybrid cooling **(Years 1 – 2)**.
- Stack optimization and miniaturization of planar designs **(Year 3)**.

The PIs are currently engaged in experimental and theoretical/computational modeling studies in micro-channel phase-change, capillary flows and interfacial phenomena, and forced convective heat, mass, and species transport that is coupled with electrochemical and reaction rate modeling. There is also a current grant from DOE/Honeywell (PI – *Manglik*) for thermal management of a PEM system.