

# The McIntosh Group : Solid Oxide Fuel Cells

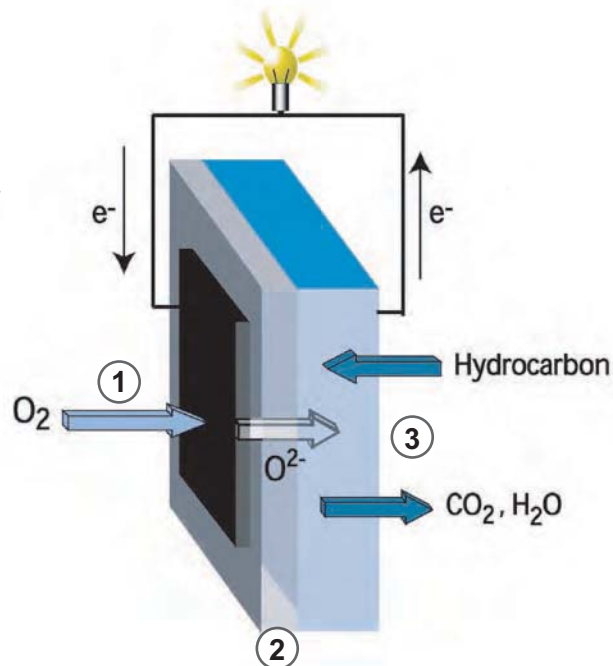
*Working towards an energy efficient future at the interface of chemical engineering, material science and electrochemistry.*

Solid Oxide Fuel Cells (SOFC) are one of the most exciting and promising technologies for meeting our future energy demands. Fuel cells promise the efficient conversion of chemical to electrical energy and are a growing area of both academic and industrial interest.

Work in the group focuses on improving the performance of SOFC electrodes by developing new materials and composites while increasing fundamental knowledge of how these materials function. Inherent in this work are considerations of catalysis, reaction engineering, materials science and electrochemistry. For example, the chemical reactions occurring on the catalyst surface also involve electrochemical processes such as electron transfer.

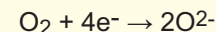
A wide range of techniques are employed to characterise both the overall SOFC system and the individual electrode materials. We aim to develop not only higher performance electrodes but also new models to describe the operation of these complex devices. Our overriding philosophy is to look for the unique angle; questioning current theory and generating new ideas.

Projects in the group encompass the range of research areas outlined above. Students utilize core chemical engineering principles while developing knowledge and skills applicable to an expanding and exciting field.



## 1. Cathode

Reduction of  $O_2$  from air:



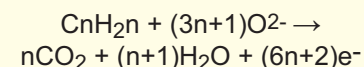
requires high ionic and electronic conductivity and rapid oxygen exchange kinetics in an oxidizing environment.

## 2. Electrolyte

Selective transport of oxygen anions - high ionic conductivity with zero electronic conductivity.

## 3. Anode

Oxidation of the fuel:



Coupling high ionic and electronic conductivity with catalytic activity towards fuel oxidation in a reducing environment.

**Tailored Composites**  
- Individual materials performing specific functions work together to create high performance electrodes.

**New materials**  
- Electron/ion conductors.  
- Anode/Cathode catalysts.

Legend:  
 □ Electron conductor  
 □ Mixed conductor  
 □ Electrolyte  
 □ Catalyst

**Catalysis**  
- High catalytic activity towards oxidation of the fuel is essential to the performance of the anode.

**Reaction Engineering**  
- SOFC electrodes incorporate many reaction/diffusion couples in both gas and solid phases.

**Modelling**  
- Combine data from model experimental systems with computation to increase fundamental knowledge.

**Experiment**  
- Develop a 'toolbox' of new techniques to characterize electrode reaction kinetics and individual material properties.

Legend:  
 □ Counter electrode  
 □ Electrolyte  
 □ Probe material  
 □ Conductor

Other project areas include high temperature membrane reactors and electrochemical sensors.

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