SOFC Electrochemical Components & Operation

SOFC Electrochemical Components

A Solid Oxide Fuel Cell has three principle electrochemical components:

Cathode – Air Side Electrode, where oxygen from the air is electrochemically spit to generate oxygen ions.

Anode – Fuel Side Electrode, where oxygen ions from the Cathode are electrochemically combined with hydrogen from the fuel to form water.

Electrolyte – Selective conductor which acts as a barrier to gas transport but conducts oxygen ions. It is at the electrode-electrolyte boundaries that the electrochemical reactions take place.

The electrolyte is a solid, nonporous metal oxide, usually Yttria (Y2O3) stabilised Zirconia (ZrO2). Cells operate at 650 to 1000ºC where efficient conduction of anode seeking oxygen ions takes place. Typically, the anode is Co-ZrO2 or Ni-ZrO2 cermet, and the cathode is Sr-dopped LaMnO3.

SOFC Operation – Electrochemical Oxidation of Hydrogen

Electrochemical reactions take place only at the interfaces between electrode and electrolyte (this interfacial layer can be thickened by appropriate fabrication). For a fuel cell supplied with methane there are three reactions possible: the direct oxidation of methane, carbon monoxide oxidation and hydrogen oxidation. Most existing fuel cells are designed for the oxidation of hydrogen, as the hydrogen reaction has more favourable kinetics. Hence the rate of the other reactions will be small and at first approximation can be omitted. During the hydrogen oxidation reaction oxygen ions from the oxidiser stream, liberated at the cathode-electrolyte interface, pass through the electrolyte to the anode-electrolyte interface where they combine with hydrogen ions, liberated there, to form water. Figure 1 is a schematic of a cell showing the constituent electrochemical reactions, their location and the electron and ion flows associated with then. The overall reaction is:

$$\mathbf{H_2 + \tfrac{1}{2}O_2 \rightarrow H_2O}$$

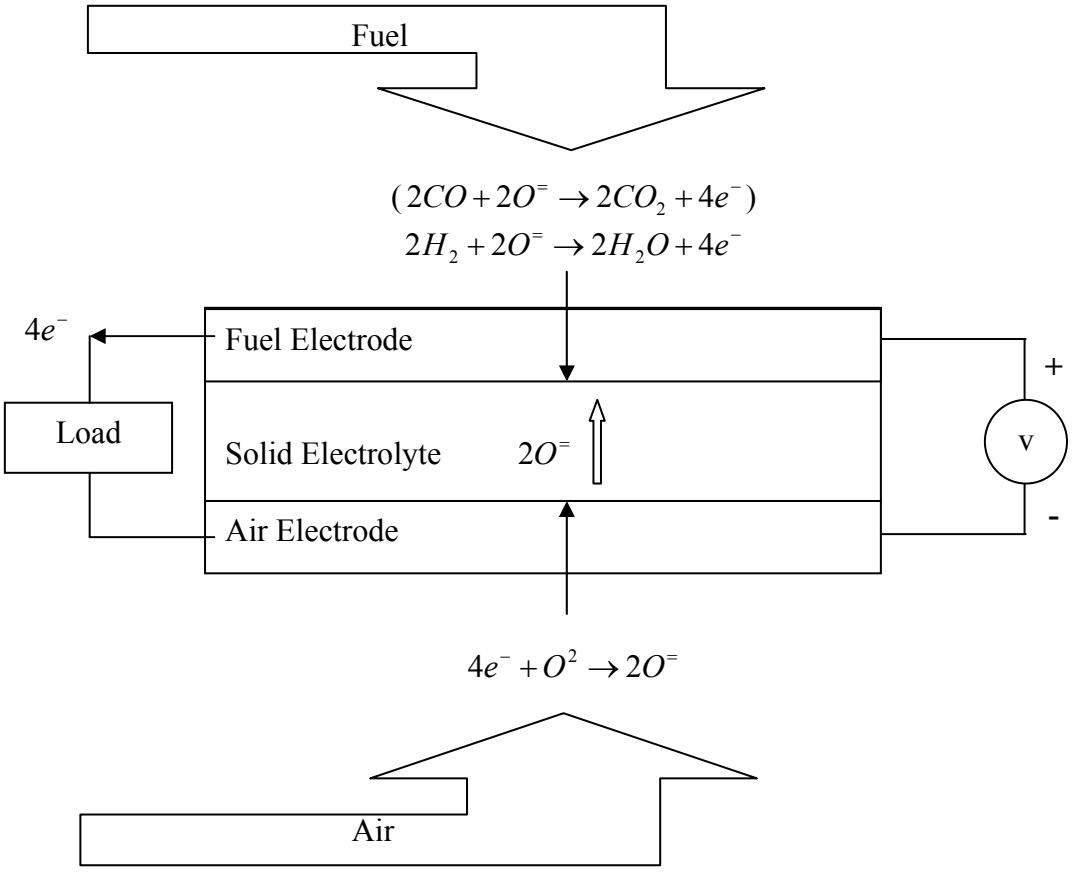

Figure 1. Schematic of fuel cell showing electrode electrochemical reactions and electron & ion flows.

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