Experimental and numerical assessment of the intricate chemical and electrochemical reactions taking place within a Solid Oxide Fuel Cell fed by biofuels: case of bio-methanol

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Abstract:

Experimental investigation of the direct utilization of biofuels in Solid Oxide Fuel Cell (SOFC) will be discussed in terms of intricate chemical reaction mechanisms and their subsequent influence on the cell electrochemistry and performance. We propose here a comprehensive modeling approach to predict the intricate anodic electrochemical reactions within a direct biofuel fed SOFC based on a H^+/O^{2-} dual ionic conducting composite electrolyte. The ionic transference number (t_n) has diect influence on the cell open circuit voltage which depends first on the biofuel nature and on the operating temperatures. The developed model enables to determine an optimum t_n value for each SOFC operating conditions.

The model will be applied to the case of bio-methanol. In fact, three electrochemical reactions scenarios associated to direct bio-methanol fed solid oxide fuel cell i.e. (1) full bio-methanol oxidation (2) total methanol reforming and subsequent light gases oxidations (3) mixed oxidation of unconverted bio-methanol and light gases will be modeled. Simulation results prove the capability of scenario 2 to predict adequately the anodic reactions mechanism indicating the total reforming of bio-methanol over the Nickel-samarium doped ceria (Ni-SDC) anode at 650 °C and the electrochemical oxidation of around 1% and 7% of methanol molecules at 700 °C and 750 °C, respectively.

Concluding, the established model is proposed to be a powerful tool to simulate and predict complex anodic reactions mechanism when powering the SOFC with any type of biofuels.

Key words: Solid oxide Fuel cell, biofuel, methanol, electrochemistry, modeling.

References

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