

First steps of a cell model centered on the direct internal reforming at the anode

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Solid oxide fuel cell (SOFC) optimisation requires detailed analysis based on both, experimental and simulated data. Whereas a rather large amount of works has been achieved on oxygen reduction at the cathode side [1,2,3], much less attention has been paid, until recently, to fuel oxidation at the anode side.

Indeed, numerous experimental data have been obtained on single cells or even small stacks fed with hydrogen, most of them being linked with a proposed physical model. However, only few simulation tools have been developed, based on these models [4,5], and if considering methane instead of hydrogen no simulation models are today available.

In the first part of this work, a review of these models is presented. The various approaches, the considered parameters and the calculated data are analyzed. A particular attention is given to the simulation model developed by A. Bieberle [5].

In the second part, a computer program model of SOFC considering the methane steam reforming taking place within the anode is presented. It is based on a kinetic approach of direct internal steam reforming of CH₄ in SOFCs anode. The following reactions are taken into account: steam reforming reaction, water-gas shift reaction, cracking of CH₄, Boudouard reaction, oxidation reaction of H₂. Gas transport is assumed to be infinitely fast leading to gas partial pressures in the anode equal to the outlet ones. In addition, mass and enthalpy balances are coupled. The first results (fig. 1-2) are presented and compared with experimental data obtained on conventional cermet anodes and on LaSrCrO₃-based anodes.

References

- [1] A.V. Virkar, J. Chen, C.W. Tanner, J.-W. Kim, *Solid State Ionics* 131 (2000) 189-198.
- [2] A. Svensson, S. Sunde, K. Nişancıoğlu, *J. Electrochem. Soc.* 145 (4) (1998) 1390-1400.
- [3] A. Mitterdorfer, L.J. Gauckler, *Solid State Ionics* 117 (1999) 187-202.
- [4] W. Lehnert, J. Meusinger, F. Thom, *J. Power Sources* 87 (2000) 57-63.
- [5] A. Bieberle, PhD Thesis, ETH Zürich, Zürich, Switzerland (2000).

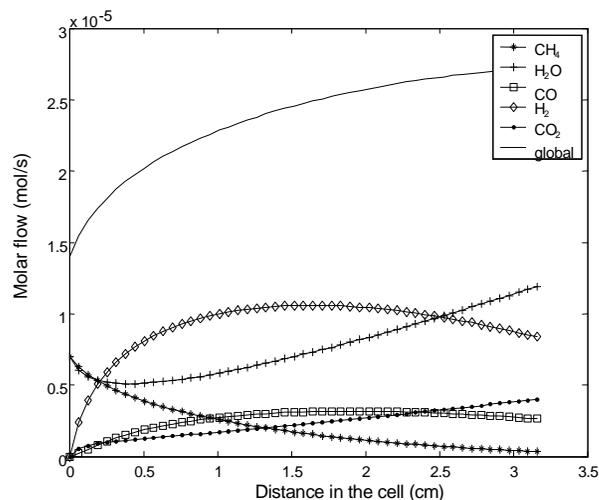


Fig. 1: Evolution of molar flows in the cell. Fuel feed: 1.4 $\mu\text{mol/s}$; S/C ratio: 1; inlet temperature of fuel: 1073 K.

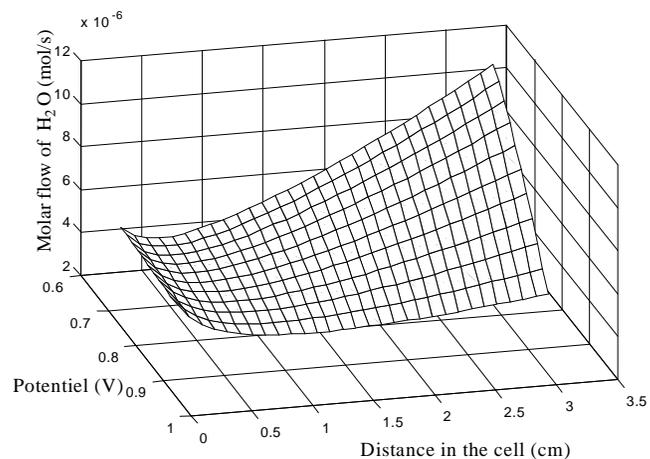


Fig. 2: Evolution of H₂O molar flow in the cell. Fuel feed: 1.4 $\mu\text{mol/s}$; S/C ratio: 1; inlet temperature of fuel: 1073 K.