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### Optimization of Electrodes for Portable Fuel Cells in relation to the nature of the fuel

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**Abstract** – The development of fuel cells depends greatly of the application domain and of the power density range expected. The problem related to the conception of portable fuel cells is obviously specific: working temperature is generally low, and the key point is the nature of the fuel feeding cell. Development of specific electrodes (both anodes and cathodes) is then crucial and depends greatly on the nature of the fuel chosen. The purpose of this talk is to discuss some of the key issues concerning mainly the electrocatalyst development.

The development of fuel cells depends greatly of the application domain and of the power density range expected. For fuel cells working at low temperature (typically from room temperature to 120°C) a large range of power densities is now possible. However the problems related to the conception of portable fuel cells is obviously totally specific: working temperature is generally lower, and the key point is the nature of the fuel feeding cell. Moreover, the power density range can go from a few microwatt per cm<sup>-2</sup> to several tens of watts per cm<sup>-2</sup>. Obviously, the development of specific electrodes (both anodes and cathodes) is crucial and depends greatly on the nature of the fuel chosen. The purpose of this talk is to discuss some of the key issues concerning mainly the electrocatalyst development with some examples of results.

The choice of the fuel is a difficult. Even if for a performance point of view, pure hydrogen is clearly the best choice, the problem of its storage is important, mainly is the case of very small devices. Different solutions can be explored such as chemical storage, i.e. hydrides compounds or aqueous solutions containing such hydrides, or others fuels such as alcohols or ethers which lead to limited performances, but much more easy to store or handle. It is the case of methanol (or other low weight alcohols) or dimethoxymethane (DMM).

The development of efficient and stable electrocatalysts depends greatly of the complete understanding of the mechanism of the electrochemical reactions involved [1-3]. The elucidation of the reaction mechanism is the key point, in order to identify the different elementary steps (rate determining step...). As example, the alcohol dissociative adsorption produces strongly different adsorbed residues ("poison" or active intermediates) and all the strategy to design active electrocatalysts is to avoid the formation of such poisons or at least to favour their removing from the electrode surface. Therefore fundamental studies to elucidate mechanisms need to be carrying out, for example with *in situ* spectroscopic techniques to determine the distribution of the adsorbed intermediates at the electrode surface. The design of new electrocatalysts allowing enhanced overall kinetics is then possible. Development of specific synthesis techniques for such nanoelectrocatalysts is then an important issue. Different options and examples will be discussed to illustrate the preparation of nanostructure catalysts with required properties: structures, composition, specific shape and size of particles.

For the cathodic side, the reaction is always the reduction of oxygen, generally from air. The kinetics of this reaction is quite low. In addition, the problem of the cross-over of the fuel from the anodic to the cathodic side is important and needs the development of catalysts tolerant to the presence of small amounts of organic compounds in the cathodic compartment.

Different examples of recent developments of portable fuel cells systems for various applications and possible alternative fuels will be commented to emphasize the importance of electrocatalysis in this field.

#### References

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