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Durable thin ceramic films for improvement of Proton Exchange Membrane (PEM) electrolysis

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The growth of renewable energy production in the latest years has made it essential to find a way to store the excess energy in an efficient and potentially large-scale, easily accessible way. Electrolysis of water can play a key role in this field, since the high purity H_2 produced can be both a powerful energy vector and a multi-purpose synthesis precursor.

One way of producing hydrogen by renewable energy is by using a PEM electrolyser (PEMEC), which is a very compact low temperature electrolyser that allows a fast response to variations in electrical power supply. Moreover, the possibility of operating at high pressure enables a direct production of compressed, storage-ready output gas, thus potentially reducing the overall costs of H_2 production and storage, if the present high cost of the PEMEC can be reduced. The state-of-the-art PEMEC uses an anode based on IrO_2/RuO_2, which deliver high catalytic activity and a good corrosion resistance to the high overvoltage conditions necessary for the oxygen evolution reaction (OER) and to the low pH environment due to the membrane. Together with the Ti separator plates, generally coated with precious metals to enhance conductivity, it results in extremely high costs.

Basic material research, to identify and develop low-cost corrosion resistant stack element materials and coatings, is therefore essential. The aim of this project is primarily to identify electronic conducting materials with high chemical stability together with low cost and high availability.

This goal will be reached with extensive testing of electronic conducting ceramics in strongly oxidizing and acid environment, simulating the OER conditions in a real cell. Moreover, the evaluation of the real potential and pH experienced *in operando* by the anode material will be targeted, for properly tuning of the testing conditions. After this first screening stage, the most promising candidates will be further tested by measurement of their conductivity and other physical properties.

In a second stage of the project, the conductive and corrosion resistant materials will be deposited in thin films onto the cell electrodes; the interconnection and the adhesion between films will be object of great attention. The materials can be deposited by mean of several techniques such as PVD, RF-sputtering and PLD. The thin films will be investigated using electric conductivity, electron microscopy and x-ray photoelectron spectroscopy (XPS) and possibly other physical and chemical methods.