Water oxidation electrocatalysis with iron-based oxides: effects of pH and applied magnetic fields

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Water oxidation is considered the bottleneck to develop an efficient and cost-effective water splitting technology. State-of-the-art water electrolyzers are still far from being competitive for hydrogen production, given the cheap and well-established hydrogen production scheme from fossil fuels. One of the challenges resides in substituting the expensive noble metal catalysts by earth-abundant counterparts while maintaining the efficiency and performance required for technological applications. The requirements for catalyst development bring additional challenges beyond performance, since the materials must be robust and active in the (typically extreme) working conditions: pH, high current densities, high oxidation potentials, nascent oxygen, etc.

Iron is the most abundant transition metal on Earth, and a preferred raw material for technological applications at large scale. When water electrolysis is expected to become a multi-ton industry supported by the energy transition policy as a major driving force, it is obvious to look for iron oxides as possible solutions to the challenge. In this lecture we will visit the opportunities for iron-based active materials as components of (photo)anodes in the search for efficient, and robust water oxidation platforms. We will describe the major problems looking at the activity/stability paradigms as a function of pH and electrolytes, along the most promising strategies to further improve their electrochemical performance: nanostructuration, doping effects, and applied external magnetic fields.