Water splitting in energy provision: Resolving the origin of the unprecedentedly high activity of non-noble nanostructured oxide systems

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Summary

This project aims to contribute to further investigate the source of the high activity towards the O_2 evolution reaction of recently reported non-noble metal oxide electrocatalytic systems, such as (Ba0.5Pr0.5)CoO3-x.

Idea

Efficient electrocatalysis for the future provision of renewable energy is dependent on the ability to develop active and stable electrode surfaces capable to generate gaseous products. For instance, water splitting in electrolysers, which is central in the hydrogen economy concept, results in the formation of gaseous H_2 and O_2. Most importantly, generation of oxygen takes place at rather extreme conditions where only few classes of oxide/perovskite materials demonstrate long-term stability. Taking into account that the majority of the energy losses in electrolysers are due to the slow kinetics of the anodic reaction, the development of better electrode catalytic materials is of decisive importance for the future hydrogen economy.

Goal of this work is exploring the reasons and conditions of the superior electrocatalytic properties for the oxygen evolution reaction (OER) of recently reported non-noble metal oxide electrocatalytic systems. These systems include for instance $(Ba_{0.5}Pr_{0.5})CoO_{3-x}$ and MnO_{2-x} in contact with alkaline aqueous solutions [Ref1] and H_2O/ionic liquid mixtures, respectively. Specifically, the following key aspects will be considered: (*a*) the influence of the oxide cluster size on the activity, selectivity and stability of the aforementioned state-of-the-art electrocatalysts in the two mentioned electrolytes, (*b*) the role of interactions between electrodes and nanostructured electrocatalysts for the observed activity, and (*c*) the impact of surface morphology, electrode and electrolyte composition on the formation of the electrocatalytic layer. The expected results will contribute to further understanding of factors governing the highest ever reported activity towards the anodic reaction under harsh conditions of H_2O electrolysis and open new opportunities in preparation of $(Ba_{0.5}Pr_{0.5})CoO_{3-x}$- and MnO_{2-x}- based (or similar) systems for practical applications, i.e. for (photo)electrochemical water splitting.