Synthesis and characterization of manganese oxides for water oxidation

Florian Lessing,[a] Philipp Kurz,[a] Harald Hillebrecht[b,*]

[a] *Institute for Inorganic and Analytical Chemistry, Albert-Ludwigs-University Freiburg, Albertstraße 21, 79104 Freiburg, Germany*

Corresponding e-mail: florian.lessing@fmf.uni-freiburg.de

Abstract:

The probably most difficult reaction to produce H2 from water is the water oxidation step. In the biological photosynthesis, water oxidation take place at the oxygen evolving complex (OEC), a $CaMn_4O_4$ cluster, this catalyst is our inspiration for the synthesis of new manganese oxide based water oxidation catalysts (WOC) by non-toxic, affordable material.[1] These oxides are full of expectation as eco-friendly water oxidation catalysts with low price. Beside pure manganese oxides (MnOx) in different oxidation states we incorporate alkaline and alkaline earth metals or transition metals like cobalt and nickel to optimize stability, size and in the end the catalytic rates.[2]

Keywords: water oxidation, bio-inspired, manganese oxides.

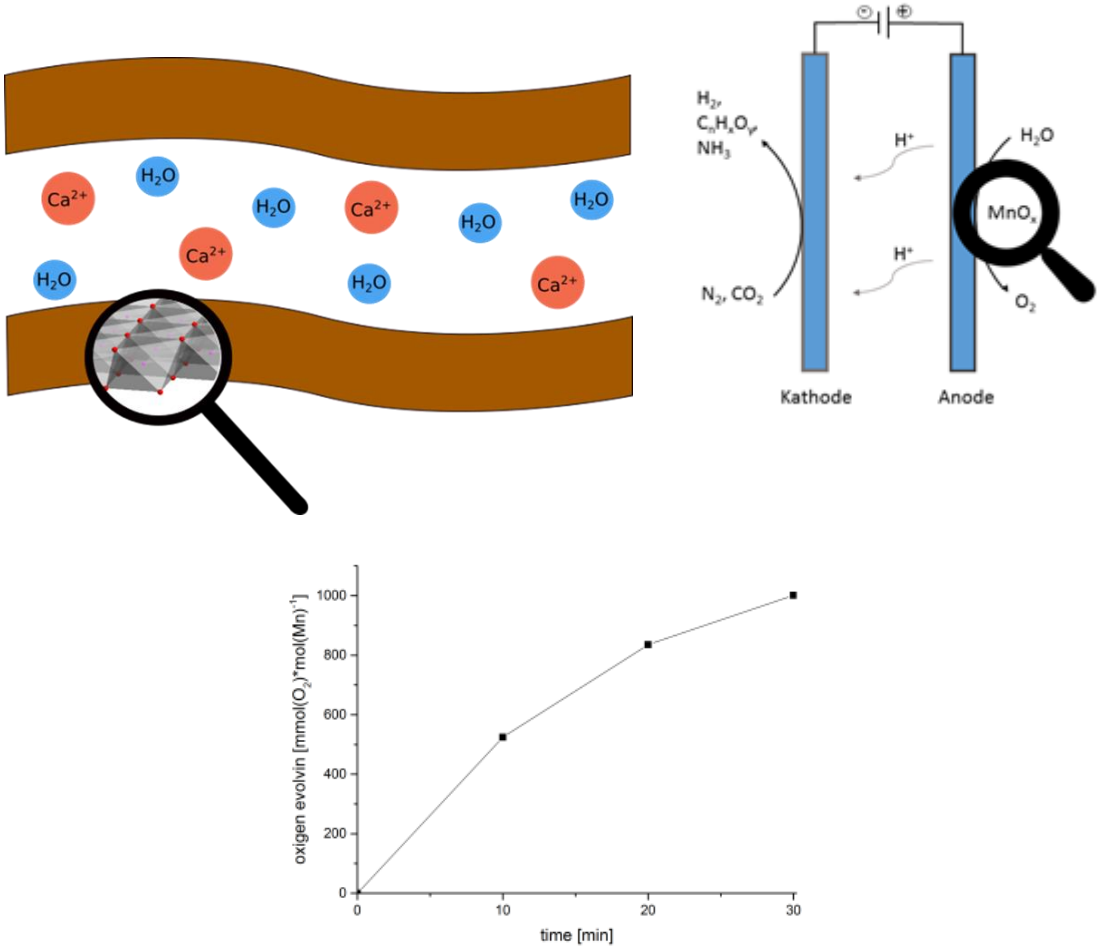

Figure 1. Schematic structure of a manganese oxide from the birnessite family (left), exemplary use in an electrochemical cell (right), catalytic rate in CAN experiment (down).

1. Introduction

A promising manganese oxide for WOC is from the birnessite family.[1,2] Birnessite has an interlayer size of 7 Å and can be synthesized in an easy way.[1,2] The interlayer of Birnessite contains water and cations, in geological Birnessite especially alkaline and alkaline earth metal cations like potassium or calcium. We found that the ion exchange in the interlayer is a very dynamic process which can take place in the synthesis and while WOC-reaction. We investigate the influence of this exchange and its influence to the catalytic properties.

2. Experimental

For the synthesis the manganese we use different of experimental methods, from simple comprtination reactions to reactions in ampule, especial oxides from the birnessite family we can synthesis up to a kg-scale. To test catalytic rate we use ceric ammonium nitrate (CAN), as a powerful one-electron oxidant and different electrochemical methods for full characterization.

3. Conclusions

Manganese oxides are a promising catalyzer for water oxidation. Compared to established catalysts based on Ru and Ir, they are very cheap, environmentally compatible and accessible via simple syntheses.

References

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