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Peter Grünberg Institute
Electronic Materials (PGI-7)

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Self-Assembling Oxide Catalyst for Efficient Electrochemical Water Splitting under Industrial Conditions

We have developed an innovative electrocatalytic material for oxygen evolution reactions (OER) in alkaline solutions. The main purpose of this activity is to make the H_2 production more effective. Our catalyst is based on perovskites with high activity (industry competitive once based on metals). At the same time – and unlike all other perovskite-based catalysts – the material is stable under industrial conditions.

H_2 technology is considered as one of the most promising "green energy" solutions. There are several different ways for H_2 production, but the electrochemical water splitting is surely the most promising one. The electrochemical water splitting is proceeded via electrolysis where H_2 is formed at the cathode and simultaneously O_2 is formed at the anode. Both reactions are coupled through electroneutrality conditions and thus, the slower reaction determines the overall reaction rate. In water electrolysis, the oxygen evolution reaction (OER) at the anode is thus the limiting factor.

The current production limitation for industry is the still too high production costs, which can be minimized by introducing more effective catalytic materials. Catalysts for the H_2 reaction are already well established and their optimization is not expected to improve sufficiently the financial reliability. However, improving the OER is the key approach for future low-cost hydrogen production.

Current catalysts for OER are metal based and the industry prefers to replace the expensive noble metal-based catalysts. Mostly Ni/Fe alloys are used or stainless steel with higher Ni/Fe content. In the past decade, perovskite catalysts already became a highly attractive alternative due to their low costs and high (electro)catalytic activity.

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Keywords:
Electrocatalysis, OER, electrochemical water splitting, hydrogen technology, green hydrogen, H_2

More Information
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Problem

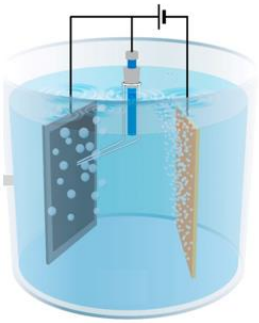
- Metal catalysts passivate with time and are less effective or too expensive (noble metals).

- The suggested perovskite catalysts work very well at lab conditions (room temperature and diluted KOH solution). However, they are highly unstable* at industrial relevant conditions (80 °C and about 5-7M KOH). For this reason, despite intensive work on their optimization

in the last 15 years, there is currently no alternative product industrially available.

*Chemical and structural instabilities that lead to complete dissolution (loss of material)

Solution



By advanced materials design (doping) we have created an innovative electrocatalytic material that, despite loss of crystallinity, preserves its excellent catalytic properties which remain chemically stable at industrial relevant conditions. This stability is comparable to catalysts widely used in industry nowadays.

Potential Use

The scope of the invention relates to catalysis of OER to increase the production rate of H_2 achieved by alkaline water electrolysis, resulting in reduced production costs.

Development Status and Next Steps

- The catalytic material has been initially developed as thin film (100-300 nm thick). Now we successfully work on powder synthesis and applying powders to electrode carriers and the transfer to semi-industrial tests.
- We also modify the catalyst using different doping elements, to test whether further improvement is possible.
- Additional applications are targeted such as high temperature (steam) electrolysis, and other related applications where the activity of OER catalyst is the limiting factor.

Forschungszentrum Jülich has extensive expertise in this field. The Peter Grünberg Institute (PGI-7) – Electronic Materials – already cooperates with numerous national and international companies and scientific partners. Forschungszentrum Jülich focuses on energy and cost-efficient devices, suitable for various emerging technologies. We are continuously seeking for licensees in this and adjacent areas of research and applications.

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