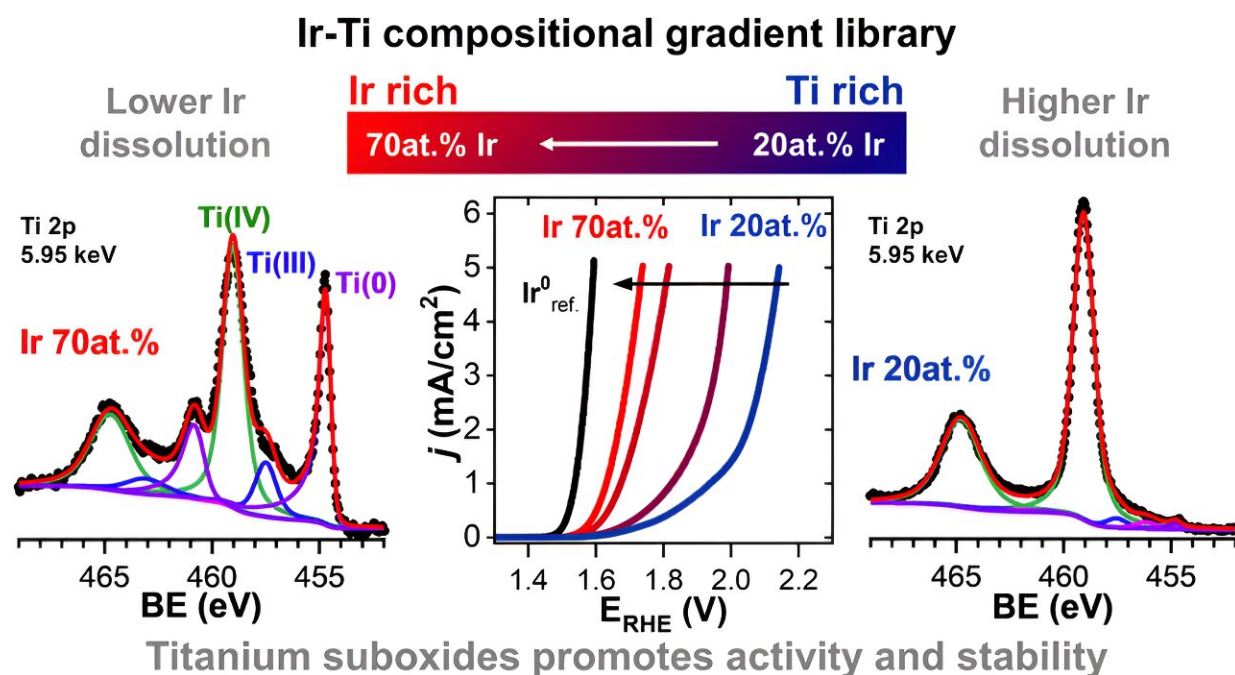


Green hydrogen: Improving the stability of iridium catalysts with titanium oxides

December 14 2023, by Antonia Rötger



Graphical abstract. Credit: *ACS Catalysis* (2023). DOI: 10.1021/acscatal.3c02948

Anodes for the electrolytic splitting of water are usually iridium-based materials. In order to increase the stability of the iridium catalyst, a team at HZB and a group at HI-ERN have now produced a so-called material library: a sample in which the concentration of iridium and titanium oxides is systematically varied.

Analyses of the individual sample segments at BESSY II in the EMIL laboratory showed that the presence of titanium oxides can increase the stability of the iridium catalyst significantly.

One option for storing energy from the sun or wind is the production of "green" hydrogen by electrolysis. Hydrogen stores energy in chemical form and releases it again when burnt, producing no exhaust gases, only water. Today, iridium is the state-of-the-art catalyst for this reaction. However, iridium increasingly dissolves in the acidic environment of the electrolysis cell so that the catalytic effect quickly wanes.

"We wanted to investigate whether the stability of the catalyst can be improved by adding different proportions of titanium oxide," says Prof Dr. Marcus Bär (HZB). Although titanium oxide is not catalytically active, it is very stable. "We had some indications that the presence of titanium oxide would have a positive effect on stability without influencing the catalytic effect of the iridium. But we also wanted to find out whether there is an ideal mixing ratio."

The sample as a materials library

The sample was produced at the Helmholtz Institute Erlangen-Nuremberg for Renewable Energies (HI-ERN) by Prof Dr. Olga Kasian's team by sputtering titanium and iridium with locally varying compositions. It is a so-called thin-film materials library on which the iridium content varies from 20% to 70%

At BESSY II; the team used X-ray spectroscopic methods to analyze how the chemical structure changes depending on the iridium content of the mixed iridium-titanium [oxide](#) samples. Several effects played a role here: for instance, the presence of titanium suboxides (such as TiO and TiO_x) improved the conductivity of the material.

Another exciting result was that some of the titanium oxides dissolve faster in the aqueous electrolyte than iridium, creating micropores on the surface. This promoted the oxygen evolution reaction because more iridium atoms from the lower layers came into contact with the electrolyte.

The main effect, however, is that titanium oxides (TiO_2 , as well as TiO and TiO_x) significantly reduce the dissolution of iridium. "In the sample with 30 % [titanium](#) added compared to a pure iridium electrode material, we saw an [iridium](#) dissolution that was approximately 70 % lower," says Marianne van der Merwe, who carried out the measurements as part of her doctorate with Marcus Bär.

High relevance for practical use

But how relevant are such results from laboratory research for industry? "If there are already established technologies, it's always difficult to change anything at first," says Marcus Bär. "But here we show how the stability of the anodes can be significantly increased with a manageable amount of effort."

The study is [published](#) in the journal *ACS Catalysis*.

More information: Marianne van der Merwe et al, The Chemical and Electronic Properties of Stability-Enhanced, Mixed Ir-TiO_x Oxygen Evolution Reaction Catalysts, *ACS Catalysis* (2023). [DOI: 10.1021/acscatal.3c02948](#)

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