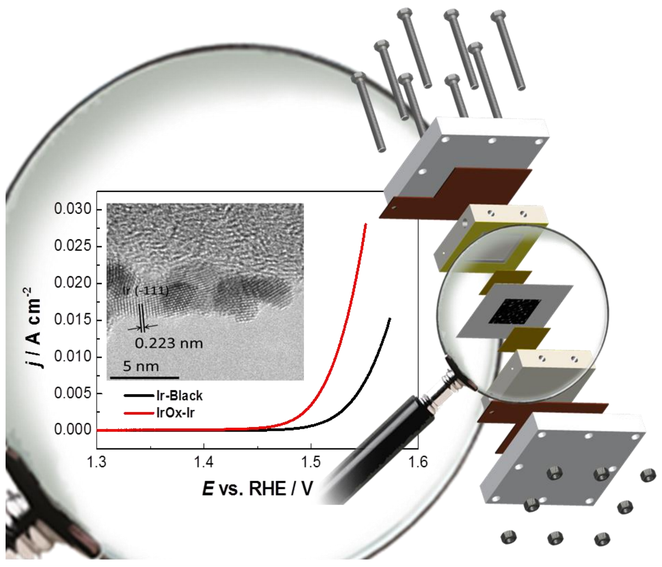
Synthesis and Characterization of Highly Active IrO_x-Ir Nanoparticles for Oxygen Evolution Reaction in Acid Media

P. Lettenmeier[a,*], **S. S. Hosseiny**[a], **L. Wang**[a], **A. S. Gago**[a], **K. A. Friedrich**[a,b]

[a] Institute of Engineering Thermodynamics, German Aerospace Center, Pfaffenwaldring 38-40, 70569 Stuttgart, Germany
[b] Institute of Energy Storage, University of Stuttgart, Keplerstraße 7, Stuttgart 70174, Germany
*Corresponding author email address: philipp.lettenmeier@dlr.de



Introduction

For the water splitting in PEM electrolyzers the choice of the oxygen evolution reaction (OER) catalyst employed at the anode has a profound impact on costs, lifetime, and efficiency of the device.[1;2] We have developed a highly active and stable nanostructured Ir catalyst for (OER) in acidic medium, synthesized by an environmental friendly, water free synthesis at room temperature.[3]

Synthesis

- Room temperature
- Waterfree
- Upscalable
- Cheep production

Dry ethanol + **$NaBH_4$**

↓

Mixing solution: Dry ethanol + **$IrCl_3$** + CTAB

↓

Reduction to **IrO_x-Ir**

Method

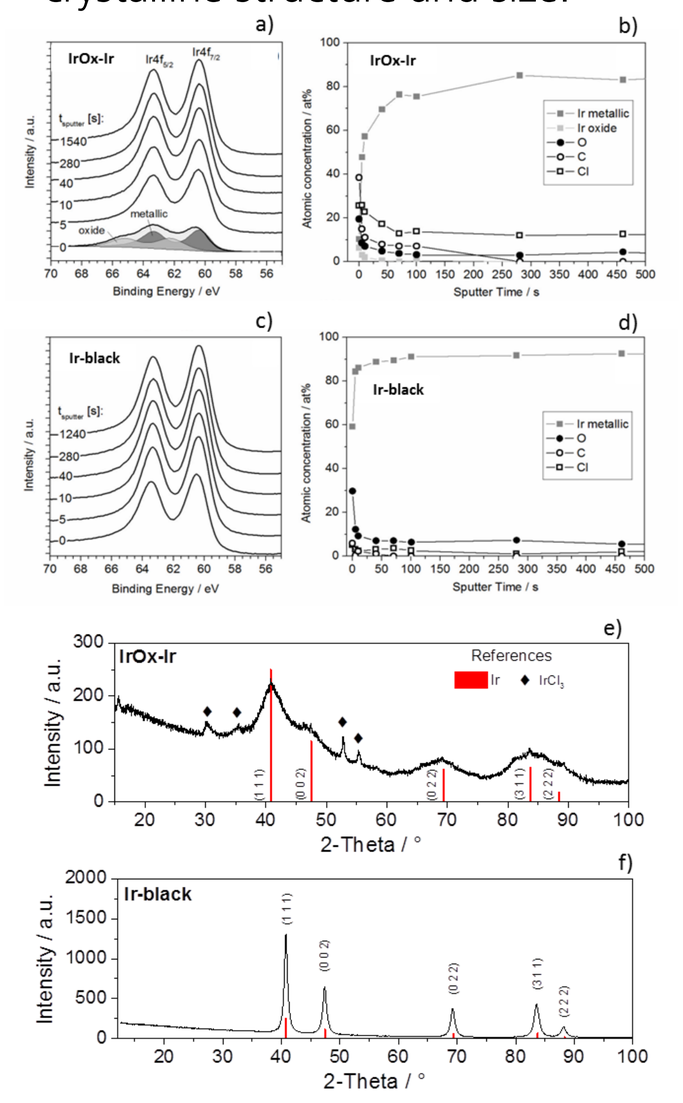
All measurements were done for IrO_x-Ir and Ir-black from Umicore, the most active, commercially available OER catalyst. IrO_x-Ir shows an up to fife-fold higher current density at an overpotential of 250mV, measured on an RDE at 25°C in Ar-saturated 0.5 M. H_2SO_4 solution.

XPS

- highly metallic materials
- thin layer of oxide

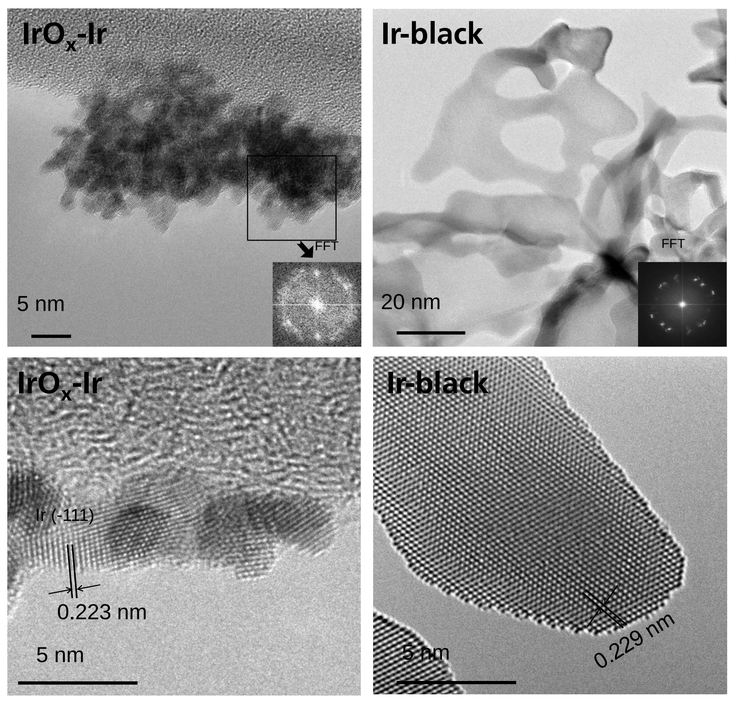
XRD

- crystalline structure and size.



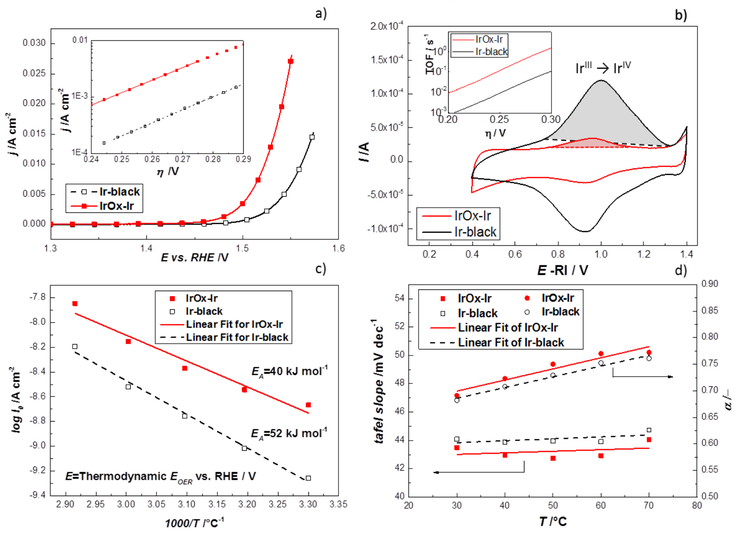
Transmission electron microscopy

- Particle size: 2nm
- High surface area:
  BET IrO_x-Ir: 60 $m^2\ g^{-1}$
  BET Ir-black: 18 $m^2\ g^{-1}$
- Similar christallin structure



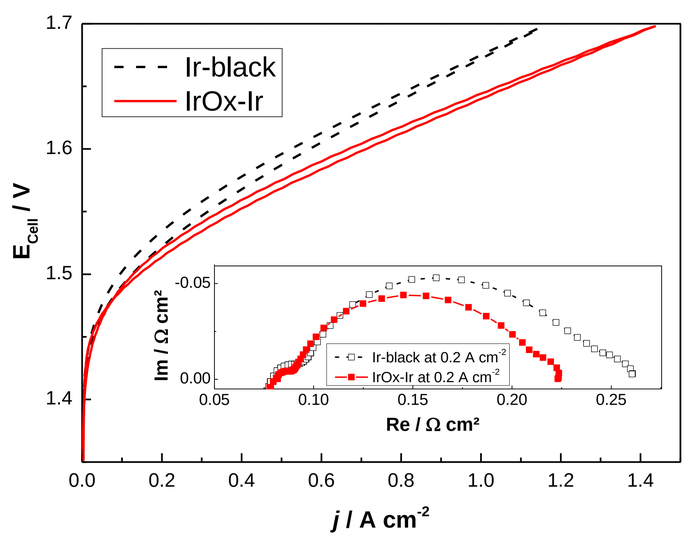
Electrochemical characterization

- High exchange current density
- Fife fold higher activity in A g^{-1}
- 6.8 time less active sites
- 13 time higher activity in A $mmol^{-1}$



PEM electrolyzer test

A MEA with 1mg catalyst loading on the Anode site was produced on Nafion 212 by wet spraying and performed in a PEM electrolyzer test stand of 25 cm^2 active area, combined with EIS measurements as an in situ characterization method. The catalyst is stable for more than 100h and shows stable performance up to 4 A cm^{-2}.



Acknowledgements

We acknowledge the German BMWi for financial support in the project No. 0325440A. We thank as well N. A. Cañas, P. Gazdzicki, I. Plock, U. Golla-Schindler for the XRD, XPS, SEM and TEM characterization, respectively; and M. Handl and R. Hiesgen for the AFM analysis.

[1] Carmo et al. 2013 [2] Marshall et al. 2007 [3] submitted for publication

Knowledge for Tomorrow

Wissen für Morgen

DLR Deutsches Zentrum für Luft- und Raumfahrt