The Molecular Design of a Metal-Oxide Supported Iridium Monolayer for Water Oxidation Catalysis

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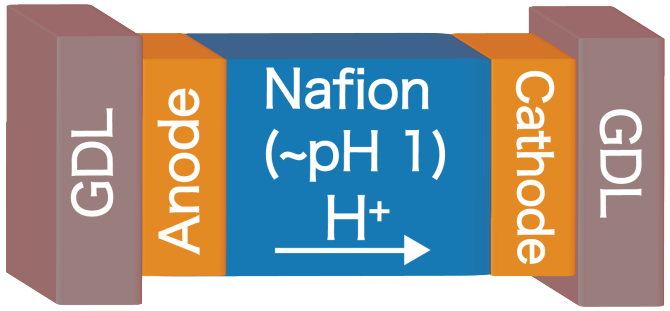
Proton Exchange Membrane Electrolysis

Proton-Exchange-Membrane Electrolyzer

The state-of-the-art technology



Water electrolysis consists of two half-reactions:

Oxygen Evolution Reaction (OER, Slow, Anode):

$2H_2O \longrightarrow 4H^+ + O_2$

Hydrogen Evolution Reaction (HER, Fast, Cathode):

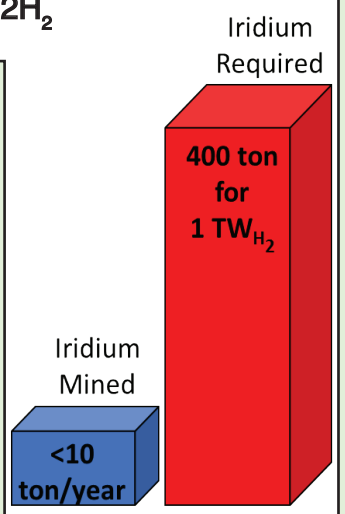
$4H^+ + 4e^- \longrightarrow 2H_2$

Advantages of PEM Electrolysis:

- High operating current densities
- Low gas crossover rates
- Relatively stable membrane material

Disadvantages:

- Acidic environment requires expensive and scarce Ir catalysts at the anode for OER



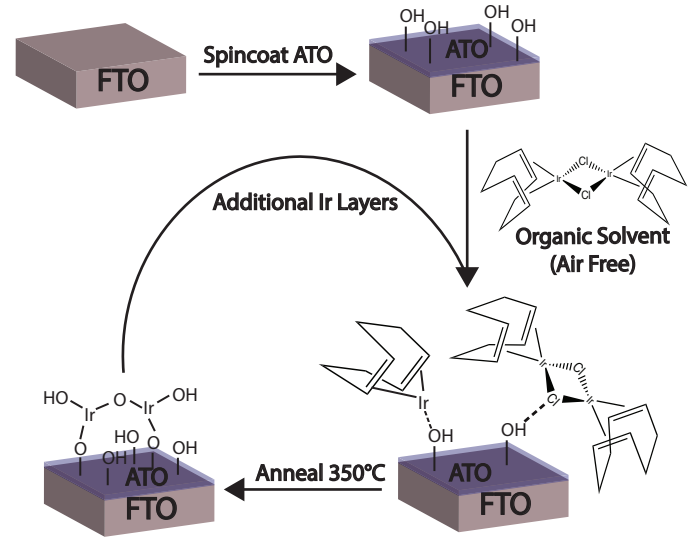
Project Goals

1) Functionalize iridium monolayers to acid-stable metal-oxide supports with atomic precision.

2) Characterize the OER catalyst to understand how catalyst activity and stability can be manipulated by modifying the catalyst architecture.

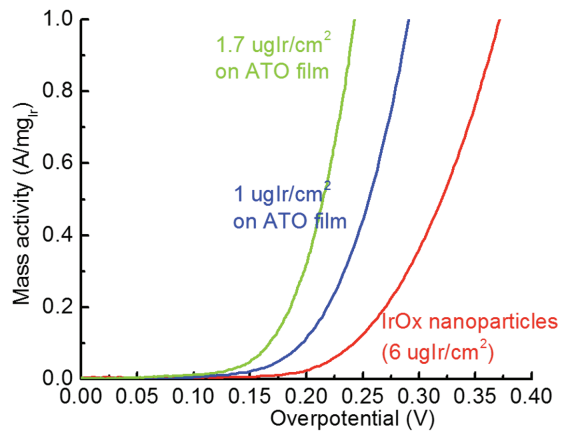
Results

Synthetic Route To an Iridium Monolayer



UV-Vis spectroscopy suggests a surface-limited binding mechanism

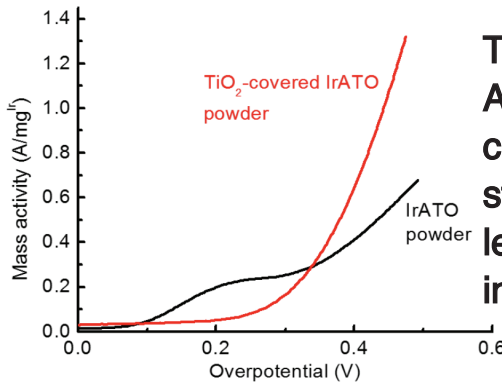
Electrochemical Measurements: High activity!



The low-loading Ir catalyst outperforms the state-of-the-art IrO_x nanoparticles.

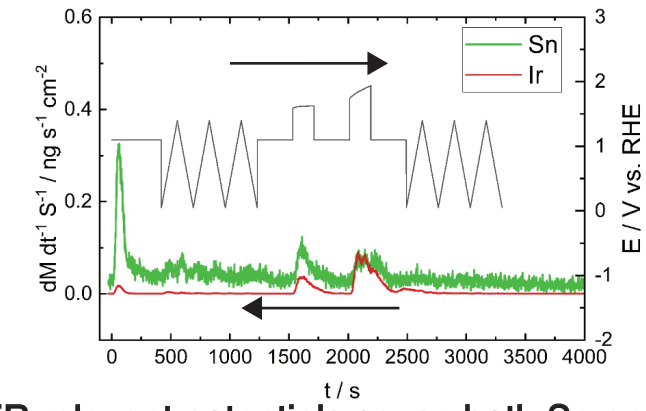
Results (continued)

TiO_2 Further Enhances OER Activity



TiO_2 deposited via ALD modulates the catalyst electronic structure which leads to significantly increased activity

Unstable Catalyst Architecture



OER relevant potentials cause both Sn and Ir dissolution per in-situ ICP-MS analysis.

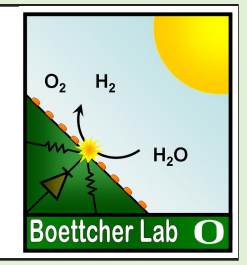
Conclusions

1. We can synthesize a low-loading Ir catalyst on metal-oxide supports with atomic precision over catalyst architecture

2. We observe significantly increased intrinsic activity, however catalyst stability remains problematic.

Anknowledgments

Dr. Shannon W. Boettcher
Raina Krivina (PhD Candidate)
Grace Lindquist (PhD Candidate)
Liam Twight (PhD Candidate)



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