Novel Substrate-Agnostic Approach in Preparing High-Performance Regenerative Water Splitting (Photo)electrodes

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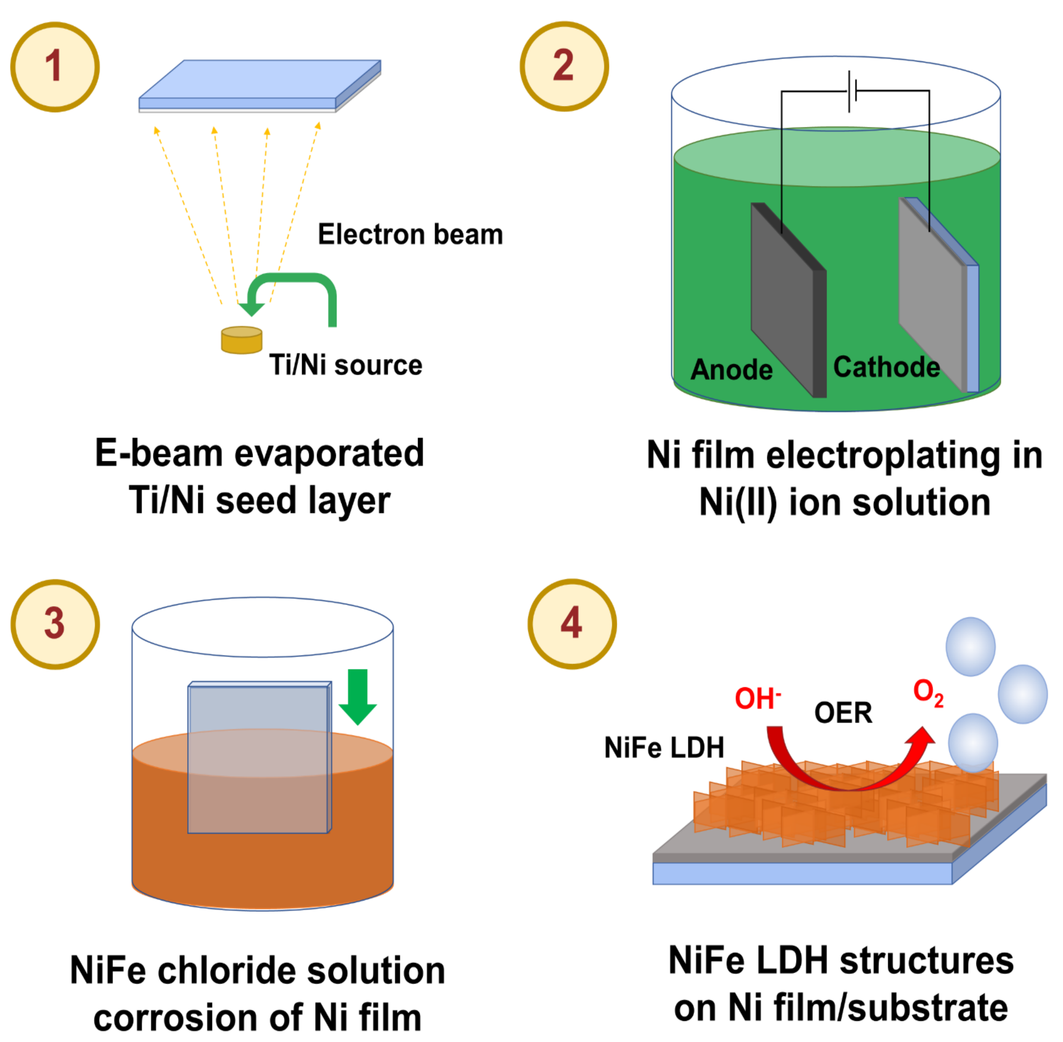
Background

- Green H_2 technologies (*e.g.*: electrolysis) not widely adopted in industry – **electrocatalysts** remain a key development bottleneck
- Current issues with existing water splitting electrocatalysts:
  - ➢Low performance in oxygen evolution reactions (OER) [1]
  - ➢Synthesized using complex, non-scalable chemical processes [2]
  - ➢Require chemically durable and conductive substrates – cost-prohibitive
- Our solution:
  - ➢Deposit multimetallic hydroxides catalysts *via* **surface corrosion[3]** on plated metal films

[1]Liang, Q. et al., J. Phys. Energy, 3, 2 (2021)
[2]Dionigi, F. et al., Adv. Energy Mater., 6, 23 (2016)
[3]Liu, Y. et al., Nat. Commun., 9, 2609 (2018)

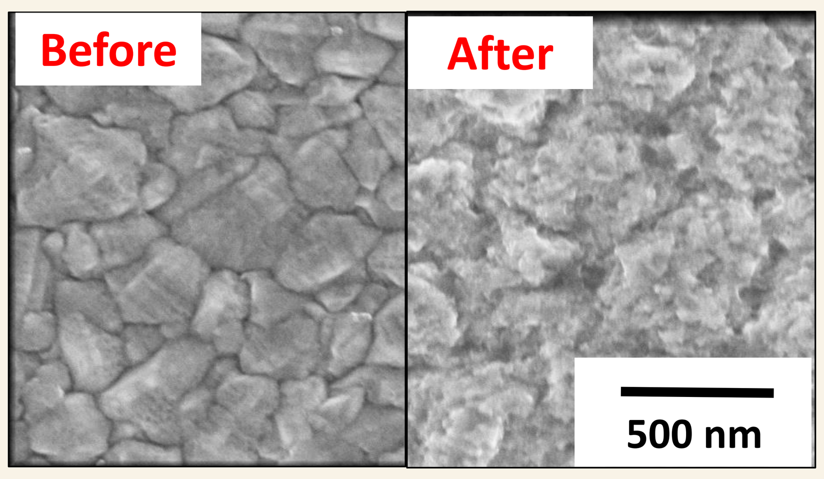
Methodology



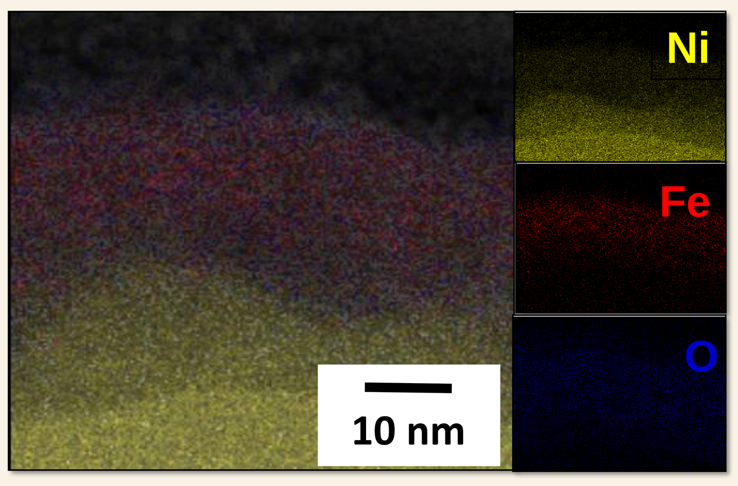
Synthesis procedure of the solution-corroded NiFe layered double hydroxide (LDH) catalyst on a substrate

Results

1 Catalyst microstructure & composition



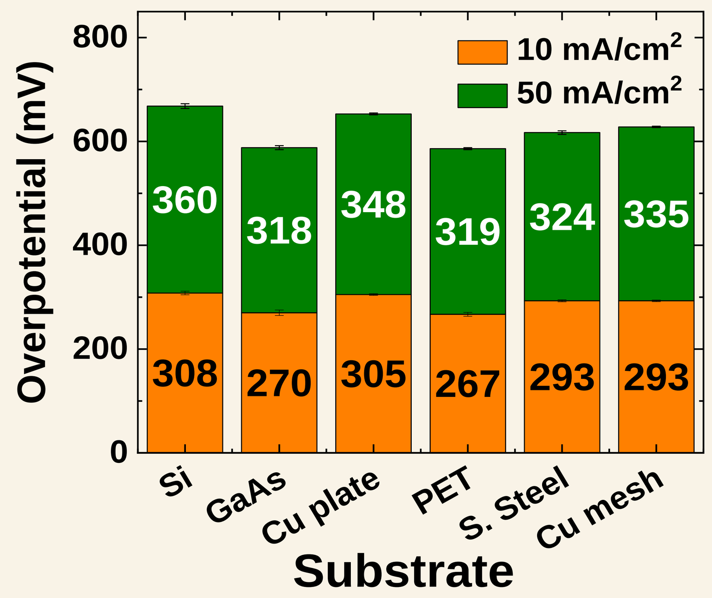
Microscopy images of Ni-plated surface film

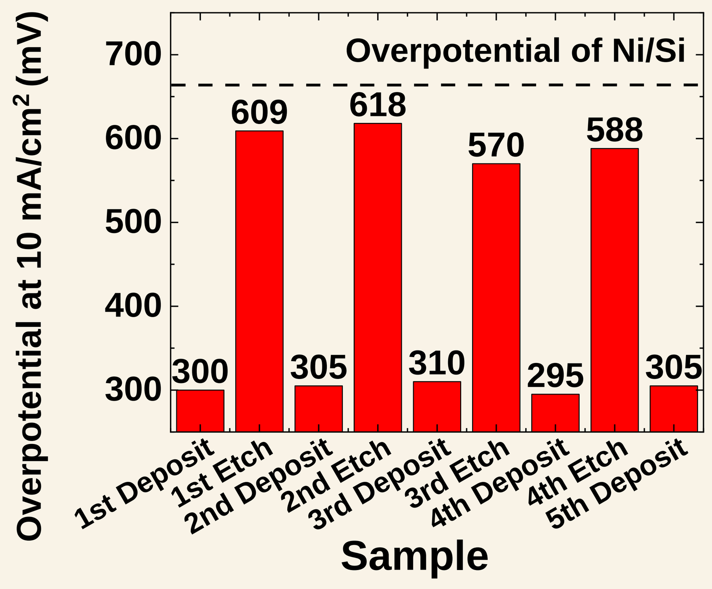


Cross-section of NiFe LDH film surface

- 11-40-nm-thick amorphous NiFe LDH film on surface
- Structural integrity of Ni film intact after corrosion

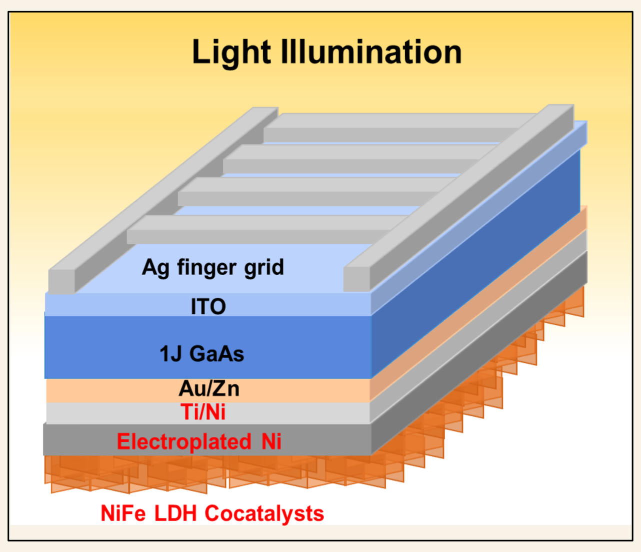
2 Substrate-agnostic & regenerative OER performance

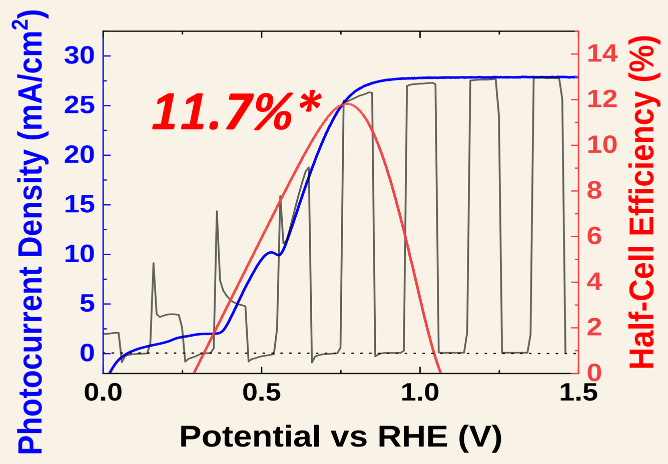




*OER overpotentials of NiFe LDH on: **(top)** Various substrates, **(bottom)** After each deposit-etch processes*

3 Decoupled NiFe LDH/GaAs photoanode with record device efficiency*

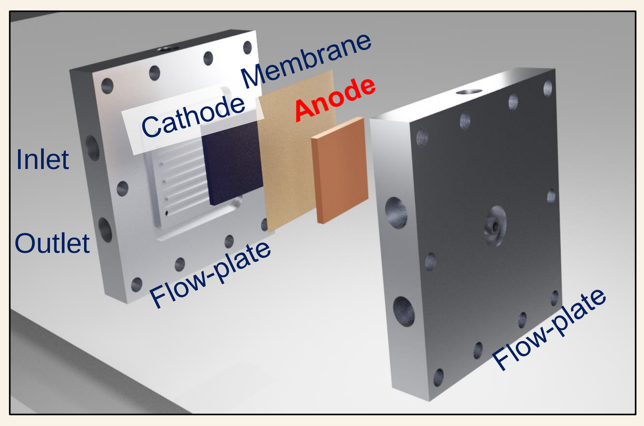


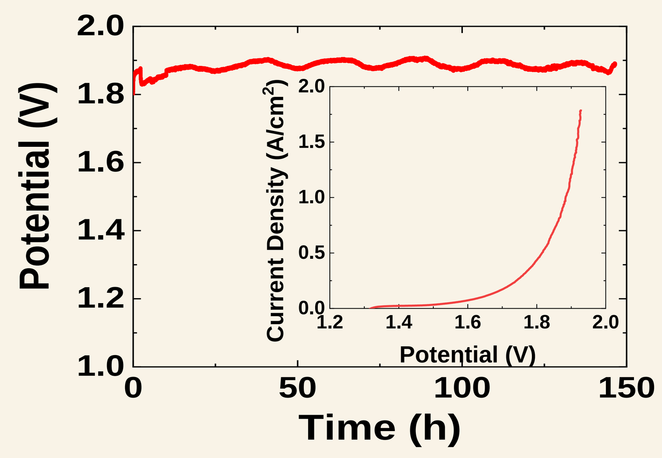


**highest single-junction photoanode efficiency*

***(Left)** Decoupled GaAs PV/NiFe LDH design, **(Right)** Photoresponse with corresponding half-cell efficiency*

4 High-current stability in electrolyser





***(Left)** Alkaline electrolyser with Pt (cathode) and NiFe LDH (anode), **(Right)** Chronopotentiometry of electrolyser device at 260 mA/cm² with (inset) corresponding linear sweep voltammetry*

Conclusion

- Key messages from our earth-abundant catalyst deposition method:
  - ➢Substrate-agnostic
  - ➢Has **regenerative** ability
  - ➢ Capable of **record photoelectrode efficiency**
  - ➢ **Excellent stability** at high current densities
- Expected to be industry-compatible for large-scale green H_2 production

Acknowledgements

We would like to acknowledge funding support by the Australian Government through the Australian Renewable Energy Agency (ARENA) and the Australian Research Council (ARC); and the use of facilities and technical support from the ACT Node of the Australian National Fabrication Facility (ANFF).

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ARENA
ANFF

Further Information

This work has been published as part of a special issue of Chemistry of Materials: *"John Goodenough at 100"* (link in QR code).

A provisional patent application is also filed with IP Australia (Appl. number: 2021903393).

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