A New Generation of Innovation

Huyen Dinh, Director of HydroGEN, NREL
9/1/2021, Virtual
Hydrogen Energy Earthshot Summit
Advanced Pathways Panel
DOE Strategy for Green Hydrogen Challenges

Consortium Approach

Make
Move
Store
Use

Crosscutting:
- Analysis
- Manufacturing
- Codes & Standards
- Prog. Mgmt

H2NEW
HydroGEN
H-Mat
H2MARC
ElectroCat
HyBlend
HydroGEN is advancing Hydrogen Shot goals by fostering cross-cutting innovation using theory-guided applied materials R&D to advance all emerging water-splitting pathways for hydrogen production.
HydroGEN Energy Materials Network (EMN)

HydroGEN Materials Capability Network (*Materials Theory, Synthesis, Characterization & Analytics*)

**HydroGEN 2.0**
(Early-Stage Materials R&D Projects, started in FY 21, $4 M/year for 3 years)

**Director**
Huyen Dinh (NREL)

**Cross-Cutting Activities**
- Data Hub
- Technology Transfer
- Website, SharePoint Site, Zotero Library

**Best Practices in Materials Characterization and Benchmarking**

**5 Lab-led R&D: Supernode**
(cross-lab collaboration)

**31 Lab – FOA Projects**

**4 Multi-Agency Projects**

Best practices are supported through personnel, equipment, expertise, capability, materials, data.

Funded by:
- NREL
- INL
- Sandia National Laboratories
- Argonne National Laboratory

AWS Research Community

---

HydroGEN: Advanced Water Splitting Materials
Diverse HydroGEN Leadership and Community

Director
Huyen Dinh (NREL)

Research

LTE Technology Lead
Bryan Pivovar/Shaun Alia (NREL)

HTE Technology Lead
Gary Groenewold/Dong Ding (INL)

PEC Technology Lead
Francesca Toma/Adam Weber (LBNL)

STCH Technology Lead
Tony McDaniel/Andrea Ambrosini (SNL)

Cross-Cutting Modeling Lead
Tadashi Ogitsu/Brandon Wood (LLNL)
Ecosystem Enables Collaboration, R&D Acceleration, and Diversity, Equity, and Inclusivity (DEI)

HydroGEN is a nationwide, inter-agency, collaborative consortium working to advance early-stage materials R&D and build a DEI community

STEM Work Force Development Example

NSF DMREF – DOE EERE HydroGEN Inter-agency Collaboration: PSU – NREL PEC Project

Experimental Validation of Designed Photocatalysts For Solar Water Splitting

Collaboration enabled development of a screening procedure (with co-validation between experiment and theory) to expedite the synthesis, characterization, and testing of the computationally predicted, most attractive materials.

Catherine Badding,1 Ismaila Dabo,2 Raymond E. Schaak,3 Héctor D. Aburúña1
1Chemistry and Chemical Biology, Cornell, 2Materials Science, Penn State, 3Chemistry, Penn State

Cathy Badding
DOE SULI Awardee (2018)
Goldwater Scholar (2019)
Community Approach to Benchmarking and Protocol Development for AWS Technologies

Accomplishments:

• 3 Annual AWS community-wide benchmarking workshops
• 36 test protocols drafted and reviewed
• 40 additional protocols in drafting process
• Engaged with new HydroGEN projects and lab experts
• Disseminated info to AWS community

Kathy Ayers, Proton OnSite (LTE)
Ellen B. Stechel, ASU (STCH);
Olga Marina, PNNL (HTE);
CX Xiang, Caltech (PEC)

Development of best practices in materials characterization and benchmarking:
critical to accelerate materials discovery and development
"Energy Material Network Data Hubs: Software Platforms for Advancing Collaborative Energy Materials Research"

**NREL Authors:** Robert White, Kris Munch, Nicholas Wunder, Nalinrat Guba, Kurt Van Allsburg, Huyen Dinh, and collaborators.


- **Materials properties**
  - Structural information: XRD Interface in collaboration with ElectroCat
  - Phase stability & Defect properties

- **Device performance**
  - Pol Curve

---

- **HydroGEN Data Hub**
  - Consortium researchers
  - Outside researchers and the public

- **Simple data interface developed**

- **Have proven capable of effectively leveraging geographically dispersed equipment resources and scientific expertise**

- **Enabled consortium in making significant advancements in their research and disseminate them the community.**
Collaboration Results in High Impact Publication and Accelerates All AWS Technologies


Key Technical Accomplishments:

- Achieved 70% PEM electrolyzer cell efficiency while improving durability & reducing cost
- Scaled up baseline cell by 8X with 9% STH efficiency & 100 h stability integrated PV-PEC system
- Discovered new STCH compounds with H₂ production capacities > state of the art at lower temperatures
- Demonstrated a metal-supported o-SOEC cell with dramatically improved stability

Experiments

Theory

Highlight

Understanding the observed exceptional stability (> 3000 hr) is crucial for a commercial use of PEC hydrogen production.
Acknowledgements

This work was fully supported by the U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy (EERE), Hydrogen and Fuel Cell Technologies Office (HFTO).

Interagency collaboration between NSF–DMREF projects and HFTO HydroGEN EMN
John Schlueter, Program Director, NSF–DMREF, Divisions of Materials Research