Energy Materials Network
U.S. Department of Energy

HydroGEN
Advanced Water Splitting Materials

Scalable Solar Fuels Production in A Reactor Train System by Thermochemical Redox Cycling of Novel Nonstoichiometric Perovskites

Dr. Xin Qian

Saint-Gobain

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DOE HydroGEN FY22 FOA Solar Fuels Project Kickoff Meeting

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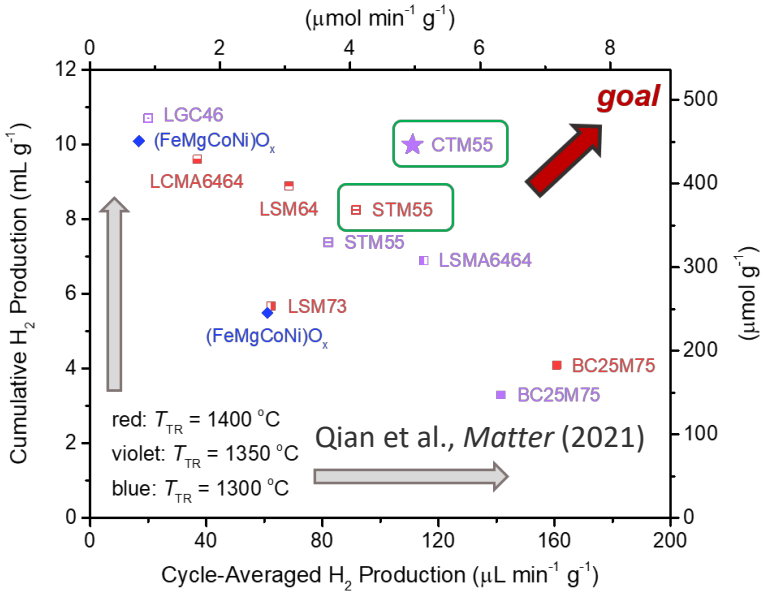
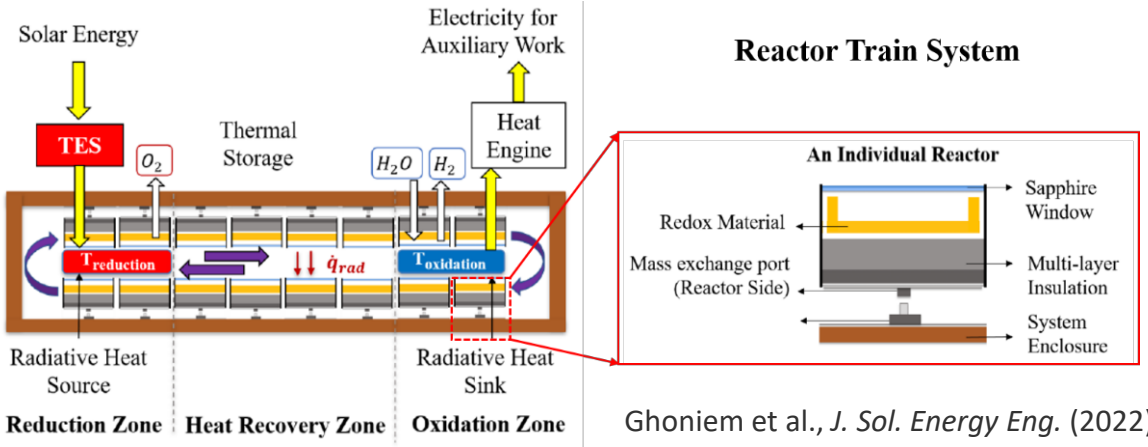
Sandia National Laboratories
INL Idaho National Laboratory
Lawrence Livermore National Laboratory

Project Overview

Technology Summary



~780 mL volume (50% porosity) to achieve 1g h^{-1} H_2



Ghoniem et al., *J. Sol. Energy Eng.* (2022)

Materials

- Build on CTM55 series;
- Maximize fuel production by optimizing Ti/Mn ratio and engineered microstructure;
- New materials discovery by high-throughput approach;

Solar Reactor

- Construct novel RTS reactor;
- Demonstrate scaled hydrogen production by material/RTS;

Project Partners

Saint-Gobain (**Dr. Xin Qian, Dr. John Pietras**), Heliogen Holdings Inc. (**Dr. Andrew Muto**), Northwestern University (**Dr. Sossina M. Haile**) MIT (**Dr. Ahmed Ghoniem, Dr. Asegun Henry**)

Program Summary

Period of performance:
36 months (10/2023 – 09/2026)

Federal funds:	$ 1,071,977
Cost-share:	$ 268,102
Total budget:	**$ 1,340,079**

Timeline	Key Milestones & Deliverables
Year 1	• Identify perovskite with $\Delta_{red}H$ in the range of 240-280 kJ $(mol\text{-}O)^{-1}$ and $\Delta_{red}S$ >90% of CTM55; • Demonstrate microstructure impact on reaction kinetics;
Year 2	• Achieve a H_2 yield ≥ 12 mL g^{-1} for ≥ 20 cycles; • Design/construct reactor to deliver > 20% efficiency;
Year 3	• Show H_2 production at target rate of 1g h^{-1}.

Technology Impact

- Develop materials/reactor combination to demonstrate scaled H_2 production at a rate ≥ 1g h^{-1} with >20 % efficiency;
- Revolutionize STCH technology to advance the commercial readiness & facilitate to achieve DOE's cost target of $1/kg-$H_2$.;
- Enhance DEI by engaging underrepresented groups in the project;
- Create potential business opportunities in concentrated solar power industries for companies such as Saint-Gobain and Heliogen;

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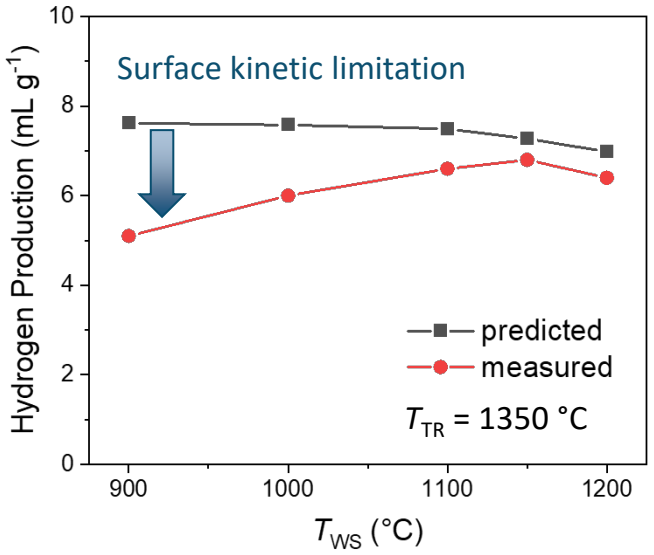

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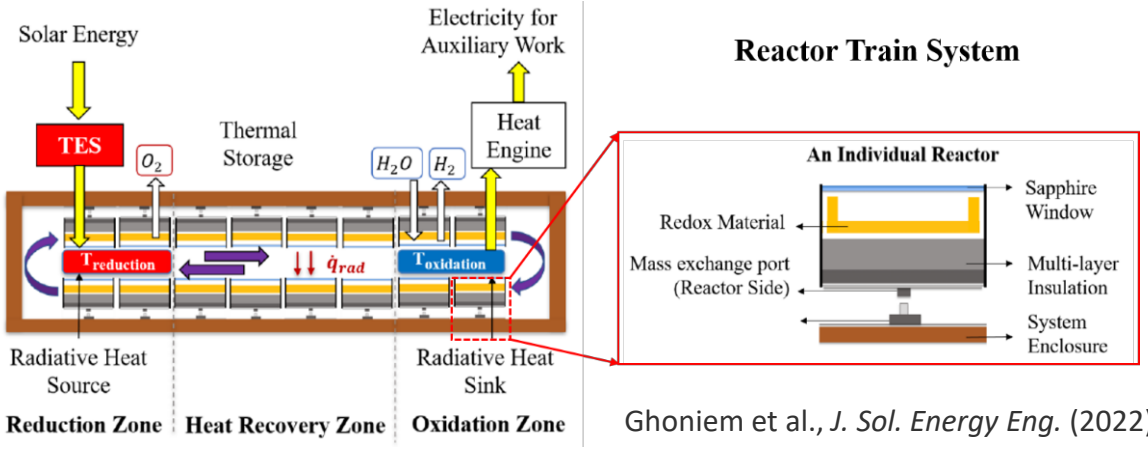

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Promoting Diversity, Equity and Inclusion

DEI Activities and Milestones

Task (T) and Milestone (M)		Leader(s)	YEAR-1				YEAR-2				YEAR-3			
			Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
T1.0 SG Annual Open House for Boston High School Students		**Dr. Qian & Dr. Pietras**												
M1.1	Host 5-10 students for onsite visit to SG with PIs													
M1.2	Host 5-10 students for onsite visit to SG with PIs													
M1.3	Host 5-10 students for onsite visit to SG with PIs													
T2.0 SG Annual Summer Intership Program		**Dr. Qian & Dr. Pietras**												
M2.1	Recruit at least 1 intern to participate in this project													
M2.2	In person seminar by Dr. Henry													
M2.3	Virtual seminar by Dr. Haile													
M2.4	Recruit at least 1 intern to participate in this project													
M2.5	In person seminar by Dr. Henry													
M2.6	Virtual seminar by Dr. Haile													
M2.7	Recruit at least 1 intern to participate in this project													
M2.8	In person seminar by Dr. Henry													
M2.9	Virtual seminar by Dr. Haile													
T3.0 Haile Undergraduate Seminar		**Dr. Haile**												
M3.1	Deliver research senimar to undergraduates in at least one other institution													
M3.2	Deliver research senimar to undergraduates in at least one other institution													
M3.3	Deliver research senimar to undergraduates in at least one other institution													
T4.0 MIT Lab Tour for K-12 Students		**Dr. Henry & Dr. Ghoniem**												
M4.1	Host 10-15 K-12 students to visit labs at MIT													
M4.2	Host 10-15 K-12 students to visit labs at MIT													
M4.3	Host 10-15 K-12 students to visit labs at MIT													

- SG recruits summer intern & hosts local students for site visit;
- SG invites co-PIs to give research seminar for visiting students;
- NU holds research seminar to educate undergraduates;
- MIT arranges lab tours for K-12 students & instruct them with general STCH knowledge
- Active recruitment at all stages from under-represented groups

HydroGEN Nodes Collaboration

Scheduled Node Support Tasks

DOE HydroGEN Node Tasks & Responsible Team					YEAR-1				YEAR-2				YEAR-3			
Task No.	**Task Description**	**Lead Team & Node PI(s)**		**Funding**	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**
node 1.0	Perovskite Oxide Water Splitting Surface Reaction Rate Calculations	LLNL	Tae Wook Heo Brandon Wood	$120,000				**M1**								
node 2.0	Technoeconomic Analysis of LCOH by Reactor Train System	NREL	Zhiwen Ma	$100,000				**M2**								
node 3.0	Validation of Thin Film Approach & X-ray Analysis of Compositionally Graded Film	NREL	Andriy Zakutayev	$130,000								**M3**				
node 4.0	High-temperature Component Testing of Reactor Train System	SNL	Ken Armijo	$135,000								**M5**				
node 5.0	Validation of Material's STCH Cycling Performance	SNL	Anthony McDaniel	$100,000												**M6**
node 6.0	Reactor Train System On-sun Testing for Solar Fuels Production	SNL	Ken Armijo	$165,000												**M7**

- Identify 6 node supporting tasks including $350k on materials research & $400k on reactor development/testing;
- Cross-node communication and collaboration are critical to ensure success of our ‘ambitious’ project goal;

Q&A

Questions?