Advanced Water-Splitting Technology Pathways Benchmarking & Protocols Workshop

Breakout Session Summaries
Cross Cutting Topics

September 21-22, 2023

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Cross Cutting Breakout Sessions

Session ID	Topic	Lead	Note Taker
C4-A	H2 Storage: Benchmarking & Validation Experience	Phil Parilla (NREL)	Karl Gross (H2 Technology Consulting)
C4-B	HTE & STCH: Common Materials	David Ginley (NREL)	Sean Bishop (SNL)
C4-C	LTE & PEC: Common Materials	Huyen Dinh (NREL)	Sol A Lee (Caltech)

Session Summary

Session ID: C4-A

Title: H2 Storage: Benchmarking & Validation Experience

Cross-Cutting Discussion Topics:

Presenter: ***Phil Parilla: NREL – Expert in Materials Hydrogen Storage Measurement Best Practices and Benchmarking.***

Goal: ***Share extensive Benchmarking experience.***

Topics:

1) Protocols, Metrics, & Recommendations
2) Validation Testing
3) Inter-laboratory Comparisons/ and Round Robin Testing
4) Lessons Learned

Consensus and Dissenting Opinions:

1) 1st measurement should be a "Blank" sample. Results that are not null point to calibration or procedural problem. Long cycle-life important for commercial success.
2) Need to ensure proper funding level to support validation efforts. Prioritize validations to be performed.
3) Test multiple identical samples to determine statistical error. For some procedures, this may not be practical. Single provider of calibration standard material/components and results.
4) Identify errors that are cell/system specific.

Key Take-Aways

1) 1st measurement: a "Blank". Non-zero results are a problem. Protocols should include "Check-off List" and require details of Operating (T-control…) & Environmental conditions (room T, P, altitude….).
2) Expert Labs needed to: a)validate result, b)to provide others standards/data for self calibration/validation, c)make protocols universal not company specific. Validation requires time, effort, and funding.
3) RR testing requires time, effort, and wide participation. Promote, incentivize, expertise
4) Lessons Learned: include in protocols or open contribution information site.

Action Items

1. Propose Level & Provider of Validation testing.
2. Develop Validation Testing goals.
3. Identify standard materials and components for calibration/validation and identify repository.
4. Prioritize validations, round-robin testing & inter-lab efforts.
5. Evaluate best way to provide community with "Lessons Learned" information.
6. Assess the level of funding needed to achieve these efforts.

Session Summary

Session ID: C4-B

Title: HTE & STCH: Common Materials

Summary of discussion

- This session looked for areas of commonality between STCH and HTE materials. The session was attended by 21 people.

Consensus and/or dissenting opinions

- People felt that cross fertilization could accelerate development in both areas.

Key Take-Aways

The two areas of the most overlap:

- Materials synthesis where in general both systems use high temperature oxides.
- The critical nature of the defect chemistry in both systems and the need for advanced characterization to understand defect formation, equilibrium and relationships to phase and materials stability. This can be supported by common theory development.

Action Items

- Consider a round robin of materials between various STCH and HTE groups.
- Develop a student exchange between research groups in the two different areas.

Session Summary

Session ID: C4-C

Title: LTE & PEC: Common Materials

Summary of discussion

- Discussed components, performance, and durability testing (operation condition, etc.), cost, and design criteria of LTE & PEC
- PEC devices have shifted to integrated PV-EC designs (without wires)
- PEC community can learn from LTE community: material & component scale up, reactor design.
- There's an opportunity to use materials and components (e.g., bipolar membrane) which were found to be unsuitable for high current operation (LTE) but may work well for PEC operating at low current densities.

Consensus and/or dissenting opinions

- Lack of understanding of degradation mechanism for PEC & LTE. PEC device has more interfaces, resulting in more complexity and points of failure, so it is hard to correlate performance loss to component failures and degradation mechanisms under different conditions.
- Different criteria for PEC (e.g., operate at lower current density, transparent material to absorb light)
- Priority to develop PEC system: durability vs. cost
- Cost: AEMWE-material costs can be lower, but it may still be hard to compete if it cannot operate at high current density (multiple stacks and systems increases balance of plant & capital cost)

Key Take-Aways

- For both PEC and LTE, elucidating the degradation mechanism, developing validating durability testing protocol(s) and accelerating stress test(s) are needed.
- Should consider the effects of operating conditions on PEC performance (trade-off between high pressure/high current densities, gas cross-over, and catalyst degradation), durability, and cost.
- Possible to adapt some of the maintenance and regeneration schemes being developed in PEC to LTE.
- For PEC to be competitive, the design must be low cost (e.g., no porous transport layer).

Action Items

- Develop metrics for PEC durability testing and methods for stable device operation (coatings, regeneration, intermittent operation, reapplying catalysts, etc.)
- Develop durability and accelerated stress test protocols

Session Attendee List

Session ID: C4-C

Title: LTE & PEC: Common Materials

Name	Affiliation
Faiz Mandani	Rice
Ayush Agrawal	Rice
Adam Nielander	SLAC
Todd Deutsch	NREL
Joel Haber	Caltech
Sarah Park	LANL
Su Min Ahn	LANL
Noor Ul Hassan	NREL
Ahmed Farghaly	ANL
Meghan Vander Woude	Chemours
Chris Topping	Tetramer
Chris Capuano	Nel Hydrogen
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Adam weber	LBNL
Johan Buurma	TNO
Issac Holmes-Gentle	EPFL
Tadashi Ogitsu	LLNL
Ai-Lin Chan	NREL

Name	Affiliation
James Vickers	DOE
Joel Ager	LBNL
Rito Yanagi	Yale
CX Xiang	Caltech
Melissa Kreider	NREL
Emily Volk	NREL
Devan Solanki	Yale
Mohamed Abdelrahman	Moleaer Inc
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Joel Ager	LBNL
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Lily Shiau	Caltech
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Balsu Lakshmanan	Versogen
Huyen Dinh	NREL
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