Advanced Water-Splitting Technology Pathways Benchmarking & Protocols Workshop

Breakout Session Summaries
Cross Cutting

May 3 – 4, 2022

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Cross Cutting Breakout Sessions

Session ID	Topic	Lead
C3-A	Lessons Learned	Karl Gross (H2 Technology Consulting)
C3-B/C	Validation & Round Robin Testing, Harmonization with International Activities	Marcelo Carmo (Nel Hydrogen) Guido Bender (NREL)
C3-D	Low Temperature vs. High Temperature (possible synergies in Mat. Science)	Huyen Dinh (NREL)
C3-E	Role of electrolyte (polymer and liquid) in PEC and LTE	Adam Weber (LBNL), Dan Miller (LBNL)

Session Summary

Session ID: C3-A

Title: Lessons Learned

Summary of discussion

- A means to provide “Lessons Learned” input from experts and beginners alike to protocol developers would be very useful.
- Round Robin measurements are critical in helping to identify differences in procedures, equipment, analysis, and reporting that will aid in refining protocols.
- Research has un-anticipated issues causing measurement problems that are not published and may be repeated by others. How to motivate the dissemination of these “Lessons Learned” to be included in protocols was discussed.

Consensus and/or dissenting opinions

- Much agreement that standard materials/systems for testing would be valuable for experiment validation.
- Improving protocols and providing opportunities to communicate best-practices is important, but;
- How could “Lessons Learned” be shared (anonymously?) in a direct and simple way to protocol authors?
- Are factors leading to performance difference considered proprietary and thus are not openly shared by industry?
- Should researchers be asked/required to repeat tests and to reveal spread of data (not just best data)?

Key Take-Aways

- While differences in materials/experimental setup vs. errors in procedures are different, both can lead to variation in results. Identifying these issues and including them in the measurement protocols is important.
- Protocol could also include results using available standard materials to serve as a validation and training.
- The history (reuse) of components being tested is an important factor that can impact results.

Action Items

- There was a lot of interest in having a repository for standards that can be accessed to test/validate measurement systems.
- Look at how “Lessons Learned” can be easily communicated in the community and included in the appropriate protocols.

Session Summary

Session ID: C3-B/C

Title: Validation & Round Robin Testing, Harmonization with International Activities

Summary of discussion

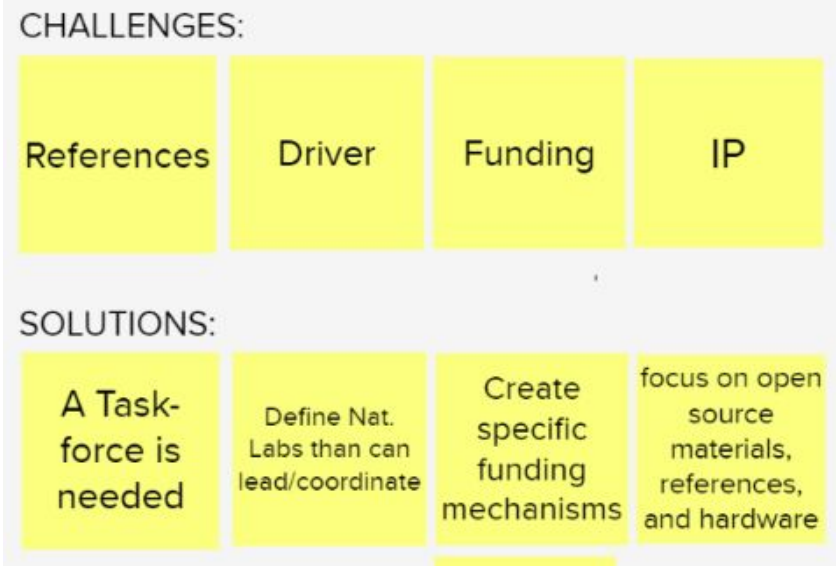
- When is a technology ready this process?
  - Materials
  - Components
  - Systems
- RRT can occur under different level (materials to systems) and frame-work

Consensus and/or dissenting opinions

- Clear consensus on the benefits for:

  harmonization □ validation □ RRT
- Foster and enables collaboration
- Creates trust and credibility
- Sharing resources

Key Take-Aways



Action Items

- Glossary (acknowledgement, adoption, publication)
- Identify technologies and their levels for harmonization/validation
- Collect names for a work-task

Session Summary

Session ID: C3-D

Title: LTE vs. HTE(Possible Synergies in Material Science)

Discussion

- Testing protocols- IV, EIS, etc.
- Perovskites catalysts
- Commercially relevant scale & scale-up
- Reversible operation
- Water purity
- Break-in cells/stacks
- Membranes and interconnects

Priorities

- Testing protocols – especially EIS
- Perovskite catalysts- understanding and modeling
- Scaling-up cells/ manufacturing – HTE learn from LTE
- Interconnects is important challenge
- Acid stable perovskite

Key Take-Aways

- Oxygen electrode is challenge
- Perovskites – mutual interest as catalysts, mechanisms, etc.
- Water impurities- depends on impurity, organics are fine for HTE, not a big cost adder
- Cell tests must be relevant to stack operation

Action Items

- Stack and cell impedance measurement and calculations
- Modeling of coupled effects of ionics, electronics, mechanisms of water oxidation
- Define HTE cell testing scales and protocols so can compare to LTE

Session Summary

Session ID: C3-E

Title: Role of Electrolyte in PEC and LTE

- Where can we find overlap in electrolyte use between PEC and LTE? Key challenges:
  - Electrode dissolution/corrosion, polymer degradation
  - AEM development, especially for benchmarking
- How can interactions of mobile ions and polymers be controlled?
- What emergent effects occur in mixed electrolytes? Could this enable new electrolytes?

- Conditions for PEC and LTE are very different (e.g., pH, current density, ΔP, etc.)
- Fundamentally different degradation phenomena in PEC and LTE (e.g., pinhole formation in PEC protective layer, modular components can be replaced in LTE)

- Key goal: understand impact of electrolyte on:
  - Reactions at electrode surface
  - Degradation of components
- Polymer electrolytes could be leveraged to control:
  - Water availability
  - Mobile ion availability
  - Gas crossover
- Polymers are messy and standard methods are needed to understand their effect on cell performance

- Develop benchmarking protocols and performance metrics:
  - “standard” liquid and polymer electrolytes
  - concentrations, pH
  - electrolyte mixtures (liquid/liquid, liquid/polymer)
  - Impact of electrolyte on electrode reactions
- Understand degradation mechanisms
- What is needed to enable the use of complex electrolytes (e.g., seawater)?