Energy Materials Network
U.S. Department of Energy

HydroGEN
Advanced Water Splitting Materials

>200 cm^2 Type-3 PEC Water Splitting Prototype Using Bandgap-Tunable Perovskite Tandem and Molecular-Scale Designer Coatings

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Sandia National Laboratories
INL Idaho National Laboratory
Lawrence Livermore National Laboratory

Project Overview

Project Partners

Shu Hu (PI), Yale University; Letian Dou (Co-PI), Purdue University

EMN Partners (Year 1-3): LBNL: Adam Weber; Joel Ager & Francesca Toma

NREL: James Young & Todd Deutsch; Kai Zhu

LLNL: Tadashi Ogitsu & Tuan Anh Pham

Project Vision

Develop a Type-3 PEC water splitting system, combining low-cost hybrid organic-inorganic perovskite (HOIP) with molecularly-engineered ALD-grown coatings of protective, conductive, and catalytic multi-functionalities

Project Impact

- Achieving high efficiency (>18%), high purity (>99.999 vol% H_2), stability (>2-week diurnal), and 0.12 gram H_2 per hour throughput;

- Discovery of <1.15 eV bandgap new hybrid perovskite materials

- Advanced integration of arrays of tandem perovskite cells with a water-splitting reactor chassis

Project Goals

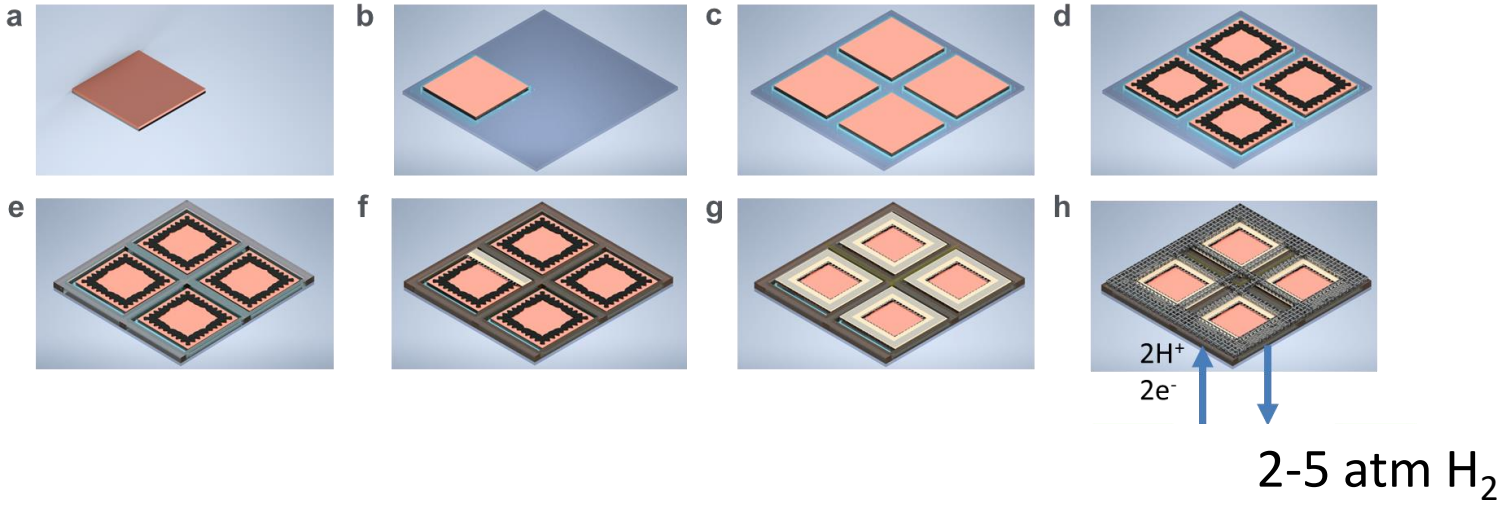
- #1: High efficiency (>18%), stability (>2-week diurnal operation), and 0.12 gram H_2 per hour throughput of >200 cm^2 light capture area
- #2: Ultra-narrow band gap HOIP materials (i.e., Eg < 1.2 eV) via doping and alloying and to optimize the thin-film processing and optoelectronic properties

Go/No-Go Check Points

- Production of hydrogen with a high purity of >99vol% and a high STH of >15% using 1.7 eV/1.2 eV tandem perovskite PEC water splitting device (BP1)
- Coating-protected photoanode with <1.2-eV perovskite absorber with continuous operation stability over 100 hours (BP2)
- PEC production of hydrogen using a 2 × 2 grid devices at >18% STH (BP2)
- 0.12 g H_2/hour unassisted water splitting system using large-area perovskite tandem achieving diurnal operation (>2 weeks) (BP3)

Approach Summary

- Streamlined coating, catalyst, and manufacturing integration procedure for cost-effective H_2 collection over a large area, tiling perovskites into a 2×2 arrangement



Highlight Intended Lab Node Collaborations

5 EMN nodes

- LBNL: Joint microscopy and multi-physics modeling effort for understanding mechano-electrochemical corrosion (Adam Weber, Joel Ager, Francesca Toma)
- NREL: Tandem photoabsorber scale-up synthesis (Kai Zhu)
- NREL: Outdoor diurnal testing (Todd Deutsch, James Young)
- LLNL: Multi-scale simulations of coating porosity and chemical transport (Tadashi Ogitsu, Tuan Anh Pham)

Acknowledgement

Q&A