Standard Operating Procedure

(SOP)

Comparison Metrics and Terms for PEC Water Splitting

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Rev 1

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Revision History

This page documents the revisions over time to the SOP. The most recent iteration should be listed in the row space, with consecutive versions following.

Date of Revision	Page(s)/Section(s) Revised	Revision Explanation
04/09/2019	All	First Release

2. Outline/Table of Contents

1. Title Page
2. Table of Contents
3. Procedures
    a. Scope and Applicability
    b. Physical Constants
    c. Definitions and Acronyms
    d. Solar-to-hydrogen (STH) conversion efficiency
    e. Cautions
4. Reference Section

3. Procedures

a. Scope and Applicability

The purpose of this SOP is to define a standard set of definitions, metrics, units, and conventions for photoelectrochemical (PEC) waters splitting. The goal is to ensure that the literature is consistent from research group to research group, and data is reported in similar formats, such that results can be compared on a similar basis. This SOP is a first draft and is intended to be revised and added to in collaboration with the PEC community.

b. Physical Constants

Constant	Value	Definition/comments
Reversible water splitting potential	1.229 V	Used to calculate LHV efficiency
Thermoneutral water splitting potential	1.48 V	Used to calculate HHV efficiency
One sun illumination	100 mW cm^{-2}	Used to calculate solar-to-fuel conversion efficiency

c. Definitions and Acronyms

Below are common acronyms and definitions used in PEC water-splitting and related characterization methods.

Acronym	Stands for	Definition/comments
AEM	Anion Exchange Membrane	Membrane which selectively conducts anions such as hydroxide
AM1.5G	Global Standard Spectrum Air mass (AM) 1.5	Global Standard Spectrum
AM1.5D	Direct Standard Spectrum Air mass (AM) 1.5	Direct Standard Spectrum
BET	Brunauer–Emmett–Teller	A method for determining surface area
CE	Counter Electrode	Auxiliary electrodes in 3-electrode setup
ECSA	Electrochemical Surface Area	Catalyst surface area that can be accessed by reactant
EQE	External Quantum Efficiency	Measurements of photo-generated carrier collection
FE	Faradaic Efficiency	Measurements of Faradaic Efficiency for OER and HER
HER	Hydrogen Evolution Reaction	Cathode reaction in the PEC device
ICP	Inductively Coupled Plasma	Method for analyzing trace metals in water
IPCE	Incident Photon-to-Current Efficiency	Measure of photo-generated carrier collection efficiency
LHV	Lower Heating Value	See discussion below

Acronym	Stands for	Definition/comments
ND	Neutral density	ND filters for adjusting illumination intensities
OER	Oxygen Evolution Reaction	Anode reaction in the electrolyzer
PEM	Proton Exchange Membrane	Membrane which selectively conducts cations
PEC	Photoelectrochemical	Solar to fuel conversion via photo-generated carriers at relatively low temperature and low flux
PV	Photovoltaic	Solar to electric conversion technology
RDE	Rotating Disk Electrode	Method for characterizing catalyst activity
RE	Reference Electrode	Electrodes for potential reference in 3-electrode setup
SEM	Scanning Electron Microscopy	Method of imaging component features
TEM	Transmission Electron Microscopy	Method of detailed structural imaging
WE	Working Electrode	Electrodes of interest in the testing
XRD	X-ray Diffraction	Method to determine catalyst crystal structure

e. Efficiency

- Discussion of 3-electrode vs. 2-electrode efficiency
- Discussion of peak efficiency vs. diurnal cycle averaged efficiency

f. Health & Safety Warning

Hydrogen is a flammable gas. It is combustible at levels of 4-75% in air. Hydrogen should only be produced in a well-ventilated area, and calculations should be performed to determine the maximum possible flow rate vs. the air flow in the area. Hydrogen can also embrittle metals over time, and materials of construction should be selected and inspected based on exposure.

4. Reference Section