

## XIV. Acronyms, Abbreviations and Definitions

$\alpha$ -AlH <sub>3</sub>	Alpha polymorph of aluminum hydride	AC	Activated carbon
~	Approximately	AC	Alternating current
@	At	ACF	Activated carbon fibers
°C	Degrees Celsius	A/cm <sup>2</sup>	Amps per square centimeter
°F	Degrees Fahrenheit	ACN	Acetonitrile
$\Delta$	Change, delta	ACNT	Aligned carbon nanotube
$\Delta G$	Gibbs free energy of reaction	AD	Anaerobic digestion
$\Delta H$	Enthalpy of reaction, Enthalpy of hydrogenation	ADG	Anaerobic digester gas
$\Delta H^\circ_f$	standard heat of formation	ADM	Air delivery module
$\Delta K$	Stress intensity factor	ADOPT	Automotive Deployment Option Projection Tool
$\Delta P$	Pressure drop, pressure change	A&E	Architecture and engineering
≈	Equals approximately	AEO	Annual Energy Outlook
>	Greater than	AER	Absorption-enhanced reforming, all-electric range
≥	Greater than or equal to	AFM	Atomic force microscopy; anti-ferromagnetic
<	Less than	AFP	Automated fiber placement
≤	Less than or equal to	AFV	Alternative fuel vehicle
$\mu$ CHX	Microscale combustor/heat exchanger	Ag	Silver
$\mu$ c-Si	Microcrystalline silicon	AGC	Activated graphitic carbon
$\mu$ m	Micrometer(s), micron(s)	AgCl	Silver chloride
$\eta$	Viscosity	AGM	Absorbed glass mat
#	Number	A-h	Amp-hour
$\Omega$	Ohm(s)	AHJ	Authorities having jurisdiction
$\Omega$ /cm <sup>2</sup>	Ohm(s) per square centimeter	AIBN	Azobisisobutyl nitrile
$\Omega$ -cm <sup>2</sup>	Ohm-square centimeter	AISI	American Iron & Steel Institute
%	Percent	Al	Aluminum
®	Registered trademark	Al*	Aluminum particles catalyzed with titanium
\$	United States dollars	Al <sub>2</sub> O <sub>3</sub>	Aluminum oxide
<sup>11</sup> B-NMR	Boron 11 Nuclear Magnetic Resonance	Al-AB	Aluminum-ammonia-borane
<sup>19</sup> FNMR	<sup>19</sup> Fluorine nuclear magnetic resonance	AlCl <sub>3</sub>	Aluminum chloride
1-D, 1D	One-dimensional	ALD	Atomic layer deposition
1Q	First quarter of the fiscal year	AlH <sub>3</sub>	Aluminum hydride; alane
2-D, 2D	Two-dimensional	ALS	Advanced Light Source at Lawrence Berkeley National Laboratory
2Q	Second quarter of the fiscal year	ALT	Accelerated life test
3-D, 3D	Three-dimensional	AM 1.5	Air Mass 1.5 solar illumination
3Q	Third quarter of the fiscal year	AMBH	Ammine metal borohydride
4Q	Fourth quarter of the fiscal year	AMFC	Anion exchange membrane fuel cell
6FPAEB-BPS100	Hexafluoro bisphenol A benzonitrile-biphenyl sulfone	AMR	Annual Merit Review
A	Ampere, amps	AMRL	Active magnetic regenerative liquefier
Å	Angstrom	AMRR	Active magnetic regenerative refrigerator
AAO	Anodic aluminum oxide	ANL	Argonne National Laboratory
AB	Ammonia-borane, NH <sub>3</sub> BH <sub>3</sub>	APC	Adaptive process control

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APR	Aqueous-phase reforming	BCM	Battery-charging mode
APU	Auxiliary power unit	BCN	Boron carbon nitride
Ar	Argon	Be	Beryllium
ARB	Air Resources Board	BE	Basic event
ARET	Alternative and renewable energy technologies	BET	Brunauer-Emmett-Teller surface area analysis method
ARRA	American Recovery and Reinvestment Act	BEV	Battery electric vehicle
As	Arsenic	BFZ1	BaFe <sub>0.90</sub> Zr <sub>0.10</sub> O <sub>3</sub>
ASAXS	Anomalous small-angle X-ray scattering	B-G	Boron doped graphitic material
a-Si	Amorphous silicon	B-H	Boron/hydrogen bond
a-SiC	Amorphous silicon carbide	B-H, BH	Borohydride
a-SiGe	Amorphous silicon germanium	BH <sub>4</sub>	Borohydride
a-SiN	Amorphous silicon nitride	Bi	Bismuth
ASME	American Society of Mechanical Engineers	BM	Ball-milled, ball mill
ASPEN	Modeling software, computer code for process analysis	bmimCl	1-butyl-3-methyl-imidazolium chloride
ASR	Area-specific resistance	BN	Boron-nitrogen
AST	Accelerated stress test	BNH	Boron-nitrogen-hydrogen
ASTM	ASTM International, originally known as the American Society for Testing and Materials	BNHx	Dehydrogenated ammonia-borane
AT	Ammonia triborane	BNL	Brookhaven National Laboratory
at%	Atomic percent	BOL	Beginning of life
ATG	Adenine,Thymine,Guanine, the 3 base combinations that indicate the first translatable amino acid on the DNA molecule	BOM	Bill of materials
atm	Atmosphere	BOP, BoP	Balance of plant
A-T-P	Aerosol through plasma	BOT	Beginning of test
ATP	Adenosine triphosphate; Advanced Technology Program	BPDC	Biphenyl-4,4'-dicarboxylate
ATPase	Adenosine triphosphatase	BPS	Bi Phenyl Sulfone
ATR	Autothermal reformer; autothermal reforming, attenuated total reflection	BPSH	Block polysulfone ether polymers
ATR-FTIR	Attenuated total reflectance Fourier transform infrared	BPV	Boiler and Pressure Vessel
ATRP	Atom transfer radical polymerization	Br	Bromine
a.u.	Arbitrary units	Br <sub>2</sub>	Diatomic bromine
Au	Gold	BSC	Bi-electrode supported cell
Avg	Average	BTE	4,4',4''-(benzene-1,3,5-triyltris(ethyne-2,1-diyl))tribenzoate
AZO	Aluminum zinc oxide	BTCD	Octa-carboxylate ligand
<sup>11</sup> B-NMR	Boron 11 Nuclear Magnetic Resonance	BTU, Btu	British thermal unit(s)
B	Boron	C	Carbon
B <sub>2</sub> O <sub>3</sub>	Boron oxide; diboron trioxide	C	Coulomb
Ba	Barium	C <sub>2</sub> H <sub>4</sub>	Ethylene
barg	Bar gauge	C <sub>2</sub> H <sub>6</sub>	Ethane
BBC	4,4',4''-(benzene-1,3,5-triyl-tris(benzene-4,1-diyl))tribenzoate	C <sub>3</sub> H <sub>8</sub>	Propane
BCC	Body-centered cubic	Ca	Calcium
		CA	Carbon aerogel
		CAD	Computer-aided design
		CAE	Computer-assisted engineering
		CAES	Compressed air energy storage
		CaFCP	California Fuel Cell Partnership
		CAFE	Corporate Average Fuel Economy

CaI	<i>Clostridium acetobutylicum</i> hydrogenase	CGO	Cerium gadolinium oxide, Gd-doped CeO <sub>2</sub>
CaO	Calcium oxide	CGS	Copper gallium diselenide, CuGaSe <sub>2</sub>
CARB	California Air Resources Board	CGSe	Copper gallium diselenide
CaS	Calcium sulfide	CGSe <sub>2</sub>	Copper gallium diselenide
CB	Conduction band	CH	Hydrogenated graphene
CBM	Conduction band minimum	cH <sub>2</sub>	Compressed hydrogen gas
CBN	Carbon-boron-nitrogen	CH <sub>4</sub>	Methane
CBS	Casa Bonita strain, complete basis set	CHARM	Cost-effective High-efficiency Advanced Reforming Module
cc	Cubic centimeter(s)	CHHP	Combined heat, hydrogen, and power
CC	Crossover current	Chl	Chlorophyll
CCC	Carbon composite catalyst	CHMC	Compressed Hydrogen Materials Compatibility
CCD	Charge-coupled device	CHP	Combined heat and power
CCD	Catalytic cracking deposition	CHPFC	Combined heat and power fuel cell
cc/g cat/hr	Cubic centimeter(s) per gram catalyst per hour	CHS	Chemical hydrogen storage
CcH2	Cryo-compressed hydrogen	CHSCoE	Chemical Hydrogen Storage Center of Excellence
CCM	Catalyst-coated membrane; coordinate measuring machine	CIGSe	Copper indium gallium diselenide
Cc/min, ccm	Cubic centimeters per minute	CIGSe <sub>2</sub>	Copper indium gallium diselenide
ccp	Cubic close-packing	CIS	CuInSe (alloy of copper, indium, and selenium)
CCP	Combined cooling and power	Cl	Chlorine
CCS	Carbon capture and storage	CL	Catalyst layer
CCVJ	9-([E]-2-carboxy-2-cyanovinyl)julolidine	cm	Centimeter
Cd	Cadmium	CM	Controls module
CD	Compact disk, charge depleting, cathode dewpoint	cm <sup>2</sup>	Square centimeter
CDC	Carbide-derived carbon	CMM	Coordinate measuring machine
cDNA	Complementary DNA	CMO	Conductive metal oxides
CDO	Code development organization	CMR	Composite membrane reactor
CDP	Composite data product	CMWNT	Carbon multi-walled nanotube
CdS	Cadmium sulfide	CN	Carbon-nitrogen
Ce	Cerium	CNF	Carbon nano-fiber
CE	Cluster Expansion	CNG	Compressed natural gas
CEA	Commissariat à l'Énergie Atomique	CNO	Cesium niobate
CEC	California Energy Commission	CNP	Combinatorial nanoparticle
CEM	Compressor/expander motor	CNT	Carbon nanotube
CEMG	Compressor expander motor-generator module	Co	Cobalt
CEMM	Compressor-expander motor module	CO	Carbon monoxide
CeO <sub>2</sub>	Ceric oxide	CO <sub>2</sub>	Carbon dioxide
CEPCI	Chemical Engineering's Plant Cost Index	CoE	Center of Excellence
CF	Carbon fiber, carbon foam	COE	Cost of electricity
CFD	Computational fluid dynamics	COF	Covalent-organic framework
cfm	Cubic feet per minute	COF <sub>2</sub>	Carbonyl fluoride
CFP	Carbon fiber paper	COPV	Composite overwrapped pressure vessel
CFRP	Carbon fiber reinforced plastic	COS	Carbon oxysulfide; carbonyl sulfide
CGH2	Compressed gaseous hydrogen	c <sub>p</sub>	Specific heat

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CpI	<i>Clostridium pasteurianum</i> [FeFe]- hydrogenase	DEDP	Distance Education Degree Program
CPO, CPOX	Catalytic partial oxidation	Deg	Degree
CPV	Composite pressure vessel	DEGDBE	Diethylene glycol dibutyl ether
Cr	Chromium	$\Delta B_a$	The difference in magnetic induction at high and low applied magnetic fields
CR	Compression ratio	$\Delta G$	Gibbs free energy of reaction
CRADA	Cooperative Research and Development Agreement	$\Delta H$	Enthalpy of reaction, Enthalpy of hydrogenation
Cs	Cesium	$\Delta H_f^\circ$	standard heat of formation
CS	Ceramic support	$\Delta K$	Stress intensity factor
C&S	Codes and standards	$\Delta P$	Pressure drop, pressure change
CSA	Canadian Standards Association	DFC	Direct fuel cell
CSA	Cell stack assembly	DFM	Design for manufacturing
CSTT	Codes and Standards Tech Team	DFMA <sup>®</sup>	Design for Manufacturing and Assembly
CSU	California State University	DFT	Density functional theory
CTAB	Cetyl trimethyl ammonium bromide	DI	Deionized, de-ionized water
CTE	Coefficient of thermal expansion	DLA	Defense Logistics Agency
CTTRANSIT	Connecticut Transit	DLC	Diamondlike carbon
Cu	Copper	dL/g	Deciliters per gram
CU	University of Colorado	DLS	Dynamic light scattering
Cu <sub>2</sub> O	Cuprous oxide	DM	Diffusion media
cu in.	Cubic inch	DMC	Diffusion Monte Carlo, direct manufactured cost
CuO	Cupric oxide, copper(II) oxide	DME	Dimethyl ether, dimethoxyethane
cu.yd.	Cubic yard(s)	DMEA	Dimethylethylamine
CV	Cyclic voltammetry; cyclic voltammogram	DMEAA	Dimethylethylamine alane
CVD	Chemical vapor deposition	DMF	n, n-di-methyl formamide
CVM	Cell voltage monitor	DMFC	Direct methanol fuel cell
CWRU	Case Western Reserve University	DNA	Deoxyribonucleic acid
CY	Calendar year	DNG	Desulfurized natural gas
CZO	Ceria-zirconia	DOD	Depth of discharge
d	Day(s)	DOD	U.S. Department of Defense
D <sub>2</sub>	Deuterium	DOE	U.S. Department of Energy
D-A	Dubinini-Astakhov	DOT	Department of Transportation
DB	Diborane (B <sub>2</sub> H <sub>6</sub> )	DOT/NHTSA	Department of Transportation/National Highway Traffic Safety Administration
dB(A)	Decibel(s) A scale	DP	Dew point
DBBPDSA	4, 4'-dibromobiphenyl 3, 3'-disulfonic acid, monomer	DP4	Design Prototype 4
DBPDSA	1, 4-dibromo phenylene 2, 5-disulfonic acid	DRIFTS	Diffuse reflectance infrared Fourier transform spectroscopy
DC	Direct current	DSC	Differential scanning calorimetry; dynamic scanning calorimetry
DCHX	Direct contact heat exchanger	DSM <sup>™</sup>	Dimensionally stable membrane
DCTDD	1,8-diazacyclotetradecane-2,7-dione	DTA	Differential thermal analysis
DDGS	Distiller's dried grains	DVD	Digital video disk
DDMEFC	Direct dimethyl ether fuel cell	e <sup>-</sup>	Electron
DDP	Detailed Data Products	E	Activation energy, kJ/mol
$d_{DR}$	Dubini-Radushkevich average micropore diameter	E85	85%-15% blend of ethanol with gasoline
DDR	A zeolite structure code		

Ea	Activation energy	ES	Energy storage
$E_{ad}$	Hydrogen adsorption heat	ESA	Electrochemically active surface area
EC	Electrochemical capacitance	et al.	<i>Et Alii</i> : and others
ECA	Electro-catalytic additive	etc.	<i>Et cetera</i> : and so on
ECA	Electrochemical area	E-TEK	Division of De Nora North America, Inc.
ECA	Estimated surface area	ETFE	Ethylene-tetrafluoroethylene
ECSA	Electrochemically active surface area, Electrochemical surface area	ETFECS	Extended thin film electrocatalyst structures
ECST	College of Engineering, Computer Science and Technology	EtOH	Ethanol
EDA	Ethylene diamine	eV	Electron volt
EDAX	Manufacturer of energy dispersive X-ray hardware and software	EVOH	Ethylene vinyl alcohol
EDS	Energy dispersive X-ray spectroscopy, energy dispersive spectrum	EW	Enthalpy wheel
EDTA	Ethylenediamine tetraacetic acid	EW	Equivalent weight
EDX	Energy dispersive X-ray	EWH	Enthalpy wheel humidifier
EECBG	Energy Efficiency and Conservation Block Grant	EXAFS	Extended X-ray absorption fine structure analysis
EELS	Electron energy loss spectroscopy	F	Fluorine
EER	Miles per unit energy of hydrogen used in a FCV/miles per unit energy of gasoline used in an ICEV	F	Faraday constant, the amount of electric charge in one mole of electrons (96,485.3383 coulomb/mole)
EERE	U.S. DOE Office of Energy Efficiency and Renewable Energy	F <sup>-</sup>	Fluorine ion
EFC	Energy flow chart	FA	Furfyl alcohol
EFP	External fuel processor	FAT	Fleet Analysis Toolkit; factory acceptance test
EFTE	Ethylene-tetrafluoroethylene	FC	Fuel cell
EHC	Electrochemical hydrogen compressor	FCB	Fuel cell bus
EHS	Environmental Health and Safety	FCC	Face-centered cubic; Fuel Cell Catalyst
EIA	Energy Information Administration of the U.S. Department of Energy	FCE	FuelCell Energy
EIS	Electrochemical impedance spectroscopy	F-Cell	Daimler Fuel Cell vehicle
EISA	Evaporation induced self assembly	FCEV	Fuel cell electric vehicle
e.g.	<i>Exempli gratia</i> : for example	FCFP	FreedomCAR and Fuel Partnership
ELAT <sup>®</sup>	Registered Trademark of De Nora North America, Inc., covers GDLs and GDEs	FCHEA	Fuel Cell Hydrogen Energy Association
EMF	Electromagnetic field	FCPP	Fuel cell power plant
EMPA	Electron microprobe	FCS	Fuel cell system
EMTEC	Edison Materials Technology Center	FCT	Fuel Cell Technologies
ENG	Expanded natural graphite	FC <sup>TESQA</sup>	Fuel Cell Testing, Safety and Quality Assurance (an international effort to harmonize fuel cell testing procedures)
eNMR	Electrochemical nuclear magnetic resonance	FCTESTNET	Fuel Cell Testing and Standardization Network
EOL	End of life	FCTT	Fuel Cell Technical Team
EOT	End of test	FCV	Fuel cell vehicle
EPA	U.S. Environmental Protection Agency	Fd	Ferredoxin
EPRI	Electric Power Research Institute	Fe	Iron
ePTFE	Expanded polytetrafluoroethylene	Fe <sub>2</sub> O <sub>3</sub>	Ferric oxide
ERW	Electric resistance weld	FEA	Finite element analysis
		FEM	Finite element model
		FEP	Fluorinated ethylene propylene; Teflon <sup>®</sup>
		FESEM	Field emission scanning electron microscope

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FF	Flammability factor	GC-MS	Gas chromatograph-mass spectroscopy
FFT	Fast fourier transform	GCNT	Graphitized carbon nanotubes
FHI	Florida Hydrogen Initiative	GCTool	Software package developed at ANL for analysis of fuel cells and other power systems
FHWA	Federal Highway Administration	Gd	Gadolinium
FIB	Focused ion beam	GDC	Gadolinium-doped ceria
FIT	Florida Institute of Technology	GDE	Gas diffusion electrode
FLUENT	Computer code for computational fluid dynamics	GDL	Gas diffusion layer
FMEA	Failure modes and effects analysis	GDM	Gas diffusion media
FOM	Federated object model	Ge	Germanium
FOM	Figure of merit	Gen I	First generation
fpi	Fins per inch	GES	Giner Electrochemical Systems, LLC
fpm	Feet per minute	GF	Glass fiber
FPS	Bis(4-fluorophenyl)sulfone, Fuel processing system	GFC	Gas flow channel
FRP	Fiber-reinforced composite piping; fiber-reinforced polymer	GGA	Generalized gradient approximation
FRR	Fluoride release rate	GGE, gge	Gasoline gallon equivalent
FSEC	Florida Solar Energy Center	GH <sub>2</sub>	Gaseous hydrogen
F-SPEEK	Fluorosulfonic acid of polyetheretherketone	GHG	Greenhouse gas
FSW	Friction stir welding	GHSV	Gas hourly space velocity
ft	Feet	GIS	Geographic information system
FT	Fault tree	GJ	Gigajoule(s)
ft <sup>2</sup>	Square feet	g/kW	Gram(s) per kilowatt
ft <sup>3</sup>	Cubic feet	GLACD	Glancing angle co-deposition
FTA	Federal Transit Administration	GLAD	Glancing angle deposition
FT-IR, FTIR	Fourier transform infrared	GLY	Glycerol
FTIR-ATR	Fourier transform infrared attenuated total reflection	Glyme	Dimethoxyethane
FTO	Fluorine-doped tin oxide	gm	Gram(s)
FTP, FTP-75	Federal Test Procedure	GM	General Motors
FW	Formula weight	gm/day	Gram(s) per day
FW	Filament winding	g/min	Gram(s) per minute
FY	Fiscal year	GNF	Graphite nanofiber
g	Gram; acceleration of gravity	GPa	Gigapascal(s)
G	Graphite	GREET	Greenhouse gases, Regulated Emissions and Energy use in Transportation model
Ga	Gallium	g/s	Grams per second
GaAs	Gallium arsenic	GSE	Ground support equipment
gal	Gallon	GTI	Gas Technology Institute
GaP	Gallium phosphide	GTR	Global Technical Regulations
GB	Gigabyte	GUI	Graphical user interface
GC	Gas chromatograph; general computational	GWe	Gigawatt(s) electric
GC	Glassy, or vitreous carbon; a pure carbon that is amorphous (non- crystalline)	h	Hour(s)
g/cc	Grams per cubic centimeter	H	Hydrogen
GCLP	Grand-canonical linear programming	H+	Proton
GCMC	Grand Canonical Monte Carlo	H <sup>-</sup>	Hydride
		H <sub>2</sub>	Diatomic hydrogen
		H2A	Hydrogen Analysis project sponsored by DOE

H2-ICE, H <sub>2</sub> ICE	Hydrogen internal combustion engine	HHV	Higher heating value
H <sub>2</sub> O	Water	HI	Hydrogen iodide, hydriodic acid
H <sub>2</sub> O <sub>2</sub>	Hydrogen peroxide	HIA	Hydrogen-induced amorphization, Hydrogen Implementing Agreement
H2QWG	DOE Hydrogen Quality Working Group	HICE	Hydrogen internal combustion engine
H <sub>2</sub> S	Hydrogen sulfide	HIx	Blend of hydrogen iodide, iodine, and water
H <sub>2</sub> SO <sub>4</sub>	Sulfuric acid	HLA	High level architecture
H <sub>3</sub> PO <sub>4</sub>	Phosphoric acid	HMC	Hyundai Motor Company
HAADF	High-angle annular dark-field	HMM	Hydrogen Market Model
HAADF-STEM	High angle annular dark field scanning transmission electron microscopy	HNEI	Hawaii Natural Energy Institute
HAMMER	Hazardous Materials Management and Emergency Response	HNO <sub>3</sub>	Nitric acid
HAVO	Hawaii Volcanoes National Park	HOPG	Highly-ordered pyrolytic graphite
HAZ	Heat affected zone	HOR	Hydrogen oxidation reaction
HAZID	Hazard Identification Analysis	hp	Horsepower
HAZOP	Hazards and Operational Safety Analysis, hazards and operability analysis	HP	High-pressure
HBP	Hyperbranched polymer	HPA	Heteropoly acid
HBr	Hydrogen bromide	HPIT	Hydrogen Powered Industrial Truck
HCC	Hybrid cathode catalyst	HPLC	High performance liquid chromatography
HCl, HCL	Hydrochloric acid, Hydrogen chloride	HPPH	1,6-di(4-hydroxyl)phenylperfluorohexane
HClO <sub>4</sub>	Perchloric acid	HPPS	<i>N,N</i> -diisopropylethylammonium 2,2-bis( <i>p</i> -hydroxyphenyl) pentafluoropropanesulfonate
H <sub>2</sub> CO	Hydrogen coordination number	HPR	Hydrogen production rate
hcp	Hexagonal close-packing	HPRD	Hydrogen pressure relief device
HDPE	High-density polyethylene	hr	Hour(s)
HDSAM	Hydrogen Delivery Scenario Analysis Model	HRA	Home refueling appliance
He	Helium	HRT	Hydraulic retention times
HE	Hydrogen embrittlement	HRTEM	High-resolution transmission electron microscopy
H-E-B	H-E-B Grocery Company, Inc.	HSC	Database name derived from the letters for enthalpy, entropy and heat capacity
HEPA	High efficiency particulate air filter	HSCoE	Hydrogen Sorption Center of Excellence
HER	Hydrogen evolution reaction	HSDC	Hydrogen Secure Data Center
HEV	Hybrid electric vehicle	HSE	High surface area electrode
HEX	Heat exchanger	HSECoE	Hydrogen Storage Engineering Center of Excellence
Hf	Hafnium	HSM	Hydrogen storage module
HF	Hydrogen Fueler	HSMCoE	Hydrogen Storage Material Center of Excellence
HF	Hydrofluorhydric acid, hydrogen fluoride, Hartree Fock	HSO <sub>4</sub>	Bisulfate anion
HFB	Hexafluorobenzene	HSP	Hydrogen safety plan
HFC	Hydrogen fuel cell	HSS	Hierarchically structured silica
HFCIT	Hydrogen, Fuel Cells and Infrastructure Technologies Program	HSSIM	Hydrogen Storage SIMulator
HFCT	Hydrogen and fuel cell technology	HSU	Humboldt State University
HFCV	Hydrogen fuel cell vehicle	HTAC	Hydrogen and Fuel Cell Technical Advisory Committee
HFI	Hydrogen Fuel Initiative	HTC	High temperature coolant
HFP	Hexafluoropropylene	HTE	High-temperature electrolysis
HFR	High-frequency resistance		
HFV	Hydrogen-fueled vehicle		

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HTF	Heat transfer fluid, Hydrogen test fixture	IGCC-CMR	Integrated gasification combined cycle-catalytic membrane reactor
HTFSA	Trifluomethylsulfonic acid	IGCC-MR	Integrated gasification combined cycle-membrane reactor
HTM	High-temperature membrane	IGCC-PBR	Integrated gasification combined cycle-paladium-based reactor
HTM	Hydrogen transport membrane	IGT	Institute of Gas Technology
HTMWG	High Temperature Membrane Working Group	IHPV	Internally heated high-pressure vessel
HTWGS	High-temperature water-gas shift	IL	Illinois
HVAC	Heating, ventilation and cooling	IL	Ionic liquid
HWD	Hot wire deposition	ILS	Integrated laboratory scale, Instrument landing systems
HWFET	Highway Fuel Economy Test	IML	Inner mold line
HX	Heat exchanger	In	Indium
HyDRA	Hydrogen Demand and Resource Analysis	In., in	Inch
HYPHER	HYdrogen PERmitting	in <sup>2</sup>	Square inch
HyPro, HYPRO	Analysis tool	INER	Institute of Nuclear Energy Research
HyS	Hybrid sulfur	InP	Indium phosphorus
HYSYS®	Process simulation software by AspenTech, computer code for flowsheet analysis	INS	Inelastic neutron scattering
HyTEC	Hydrogen Technology and Energy Curriculum	IOS	Intelligent Optical Systems, Inc.
HyTEch	Hydrogen Technical Experimental (database)	IP	Induction period
HyTRANS	DOE's market simulation model for the transition to hydrogen vehicles	IP	Intellectual property
Hz	Hertz	IPA	Isophthalate
HZM	Hot zone module	IPA	Isopropyl alcohol
i	Current density (mA/cm <sup>2</sup> )	IPCC	Intergovernmental Panel on Climate Change
I	Current	IPES	Inverse photoemission spectroscopy
I <sub>2</sub>	Diatomic iodine	IPHE	International Partnership for the Hydrogen Economy
IC	Internal combustion	IR	Infrared
ICC	International Code Council	iR	Internal resistance; voltage loss due to resistance
ICE	Internal combustion engine	Ir	Iridium
ICEV	Internal combustion engine vehicle	IR/DC	Infrared diagnostic system with direct current excitation
ICP	Inductively coupled plasma	IRMOF	Isorecticular metal organic framework
ICPME	Institut de Chimie et des Matériaux	IrO <sub>x</sub>	Iridium oxide
ICP-MS	Inductively coupled plasma mass spectrometry	ISO	International Organization for Standardization
ICR	Interfacial contact resistance	ISS	Ion scattering spectroscopy
ID	Inside diameter	ITM	Ion transport membrane
i.e.	<i>id est</i> : that is	ITO	Indium tin oxide
IEA	International Energy Agency	ITP	Indium tin phosphate
IEA-HIA	International Energy Agency Hydrogen Implementing Agreement	IV	Current-voltage
IEC	Ion exchange capacity; milliequivalents of acid groups per gram of material	J	Current
IFC	International Fire Code	J	Hydrogen flux through the membrane, ml/[cm <sup>2</sup> -min]
IFE	In-flight entertainment	J	Joule(s)
IGCC	Integrated gasification combined cycle	JFK	John F. Kennedy (airport)



JM	Johnson Matthey	LANL	Los Alamos National Laboratory
JMFC	Johnson-Matthey Fuel Cells, Inc.	LAO	Lanthanum-modified alumina
JPL	Jet Propulsion Laboratory	LAX	Los Angeles International Airport
JRC	Joint Research Centre	lb	Pound(s)
J-V	Current density-voltage	LBM	Lattice Boltzmann method
K	Sievert's constant, ml/[cm <sup>2</sup> -min-atm <sup>1/2</sup> ]	lbmol	Pound-mole(s)
K	Kelvin, absolute temperature	LBL	Lawrence Berkeley National Laboratory
K	Potassium	LC	Liquid carrier
kÅ	1000 angstroms	LCA	Life cycle assessment; life-cycle analysis
kA/m <sup>2</sup>	Kilo-ampere(s) per square meter	LCC	Life cycle cost
kb	Kilo-base pair, a unit of measurement used in genetics equal to 1,000 nucleotides	LCC	La <sub>0.7</sub> Ca <sub>0.3</sub> CrO <sub>3-δ</sub>
KBr	Potassium bromide	LCH <sub>2</sub>	Hydrogenated liquid carrier; compressed hydrogen produced from liquid hydrogen
kcal	Kilocalorie(s)	LCH <sub>2</sub>	Liquid to compressed hydrogen
kcal/mol	Kilocalorie(s) per mole	LC-MS	Liquid chromatography-mass spectroscopy
KeV	Kilo electron volt(s)	L/D	Length to diameter ratio
kg	Kilogram(s)	LDPE	Low density poly-ethylene
kg/d	Kilogram(s) per day	LDV	Light-duty vehicle
kg/hr	Kilogram(s) per hour	LED	Light emitting diode
kg/m <sup>3</sup>	Kilogram(s) per cubic meter	LEF	linear electron transfer
KH	Potassium hydride	LEL	Lower explosion limit
kHz	Kilohertz	LFG	Landfill gas
K <sub>IH</sub>	Fracture toughness measured in hydrogen gas	LFL	Lower flammability limit
kJ	Kilojoule(s)	L/h, l/h	Liter(s) per hour
K <sub>JIC</sub>	Fracture toughness	LH <sub>2</sub> , LH <sub>2</sub>	Liquid hydrogen
kJ/mol	Kilojoule(s) per mole	LHC	Light-harvesting chlorophyll
km	Kilometer(s)	LHS	Lawrence Hall of Science
KMC	Kinetic Monte Carlo, Kilauea Military Camp, Kia Motors Corporation	LHSV	Liquid hourly space velocity, h <sup>-1</sup>
KOH	Potassium hydroxide	LHV	Lower heating value
kPa	Kilopascal(s)	Li	Lithium
kph	Kilometer(s) per hour	Li <sub>3</sub> N	Lithium nitride
K <sub>th</sub> , K <sub>th</sub>	Fracture toughness threshold	Li-AB	Lithium amidoborane, Li-NH <sub>2</sub> -BH <sub>3</sub>
K <sub>TH</sub>	Hydrogen-assisted crack growth threshold	LiBH <sub>4</sub>	Lithium borohydride
kW	Kilowatt(s)	LIBS	Laser-induced breakdown spectroscopy
kW <sub>e</sub>	Kilowatt(s) electric	LiH	Lithium hydride
kWh	Kilowatt-hour(s)	LIM	Liquid injection molding, liquid injection moldable
kWh/kg	Kilowatt-hour(s) per kilogram	LLC	Limited Liability Company
kWh/L	Kilowatt-hour(s) per liter	LLC	Lessons Learned Corner
kW/kg	Kilowatt(s) per kilogram	LLNL	Lawrence Livermore National Laboratory
kWt	Kilowatt(s) thermal	LMWO	Lanthanum molybdenum tungsten oxide (e.g., La <sub>2</sub> Mo <sub>1.8</sub> W <sub>0.2</sub> O <sub>9-x</sub> )
L, l	Liter(s)	L/min, l/min	Liter(s) per minute
La	Lanthanum	LN <sub>2</sub>	Liquid nitrogen
LAGP	Lithium aluminum germanium phosphate	LNG	Liquefied natural gas
λ	Lambda, hydration number	LOD	Limit of detection
LAMH	Lithium amide and magnesium hydride	LP	Lattice parameter

#### XIV. Acronyms, Abbreviations and Definitions

LPG	Liquefied petroleum gas	MASC	Multi-acid side-chain
LPM	Liters per minute	MB	Megabyte
LPR	Liquid-phase reforming	MBE	Molecular beam epitaxy
LQ*	Dehydrogenated liquid carrier	MBL	Modified boundary layer
LQ*H2	Hydrogenated liquid carrier	MBMS	Molecular beam mass spectrometry
LRS	Laser raman spectroscopy	MBRC	Miles between roadcall
LSAC	Low surface area carbon	MC	Monte Carlo
LSC	Lanthanum strontium cobalt oxide, (La, Sr) CoO <sub>3</sub> , strontium-doped lanthanum cobaltite, La <sub>0.8</sub> Sr <sub>0.2</sub> CoO <sub>3+δ</sub>	MC	Microchannel
LSCF	Lanthanum strontium cobalt iron oxide, (La, Sr)(Co, Fe)O <sub>3</sub>	MC	Methyl cellulose
LSCM	Lanthanum strontium chromium manganese oxide, (La, Sr)(Cr, Mn)O <sub>3</sub>	mC <sup>2</sup>	Multi-component composite (membrane)
LSCr	Lanthanum strontium chromium oxide, (La, Sr)CrO <sub>3</sub>	MCB	Marine Corps Base
LSL	Lower specification limit	mC-cm <sup>-2</sup>	MilliCoulomb(s) per square centimeter
LSM	Lanthanum strontium manganese	MCFC	Molten carbonate fuel cell
LSMO	Lanthanum strontium manganese oxide, (La, Sr)MnO <sub>3</sub> , strontium-doped lanthanum manganite, La <sub>0.8</sub> Sr <sub>0.2</sub> MnO <sub>3+δ</sub>	mCHP	Micro-combined heat and power
LST	Lanthanum strontium titanium oxide, (La, Sr)TiO <sub>3</sub>	μc-Si	Microcrystalline silicon
LSV	Lanthanum strontium vanadate, Linear sweep voltammetry	MDE	Mid-duty electric
LT	Low-temperature	MDES	Methyl-diethoxy silane
LTC	Low temperature coolant	MEA	Membrane electrode assembly
m	Meter(s)	MeAB	Methylamine borane
M	Mole, molar	MEC	Microbial electrolysis cell, Minimum explosive concentration
M	Million	MeCN	Acetonitrile
m <sup>2</sup>	Square meter(s)	MeOH	Methanol
m <sup>2</sup> /g	Square meter(s) per gram	MEP	Minimum energy pathway
m <sup>2</sup> /s	Square meter(s) per second	meq	Milliequivalents
m <sup>3</sup>	Cubic meter(s)	meq/g	Milliequivalents/gram
MA	Mass activity; methyl acrylate	MeV	Mega electron volt
MAAT	Many-at-a-time	MFI	A zeolite structure code
μA	Micro ampere(s)	Mg	Megagram(s)
mA	MilliAmps (s)	μg	Microgram(s)
MA	Mass activity	mg	Milligram(s)
M-AB	Metal ammonia-borane	MG	Miscanthus giganteus
MAB, M-AB	Metal amidoboranes	MgCl <sub>2</sub>	Magnesium chloride
μA/cm <sup>2</sup>	Micro ampere(s) per square centimeter	mg/cm <sup>2</sup>	Milligram(s) per square centimeter
mA/cm <sup>2</sup>	Milliamp(s) per square centimeter	MgH <sub>2</sub>	Magnesium hydride
MAS	Magic angle spinning	MgO	Magnesium oxide
MAS <sup>11</sup> B-NMR	Magic angle spinning boron-11 nuclear magnetic resonance spectroscopy	Mg(OH) <sub>2</sub>	Magnesium hydroxide
MAS-NMR	Magic angle spinning nuclear magnetic resonance	MH, M-H	Metal hydride
		MHC	Metal hydride-based compressor
		MHCoE	Metal Hydride Center of Excellence
		MHE	Material handling equipment
		MHz	Megahertz
		mi	Mile(s)
		μCHP	Micro-combined heat and power
		μCHX	Microscale combustor/heat exchanger
		MIE	Minimum ignition energy
		MIEC	Mixed ionic and electronic conduction

mi/kg	Mile(s) per kilogram	MSR	Metal-steam reforming
mil	Millimeter(s)	MSR	Membrane steam reformer
min	Minute(s)	MTBF	Mean time between failure
MIT	Massachusetts Institute of Technology	MTBR	Mean time between repairs
MiTi®	Mohawk Innovative Technologies Inc.	mtorr	Millitorr
MJ	Megajoule(s)	μV	Micro volt(s)
mL, ml	Milliliter(s)	mV	Millivolt(s)
ML	Monolayer	MV	Methyl viologen
MLCT	Metal-to-ligand charge-transfer	mW	Milliwatt(s)
MLI	Multi-layer vacuum insulation	MW	Megawatt(s)
μm	Micrometer(s); micron(s)	MW	Molecular weight
μM	Micromolar	mW/cm <sup>2</sup>	Milliwatt(s) per square centimeter
mM	Millimolar	MWCNT	Multiple-wall carbon nanotube
mm	Millimeter(s)	MWe	Megawatt(s) electric
MMBtu	Million British thermal units	MWh	Megawatt-hour(s)
MMOF	Microporous metal-organic framework	MWNT	Multi-wall carbon nanotube
mmol	Millimole(s)	MWOE	Midwest Optoelectronics, LLC
μmol	Micromole(s)	MWth	Megawatt(s) thermal
MMT	Million metric tonnes	MYPP	Multi-Year Program Plan (the HFCIT Program's Multi-Year Research, Development and Demonstration Plan), Multi-year product plan
Mn	Manganese	MYRDD, MYRD&DP	Multi-Year Research, Development and Demonstration Plan
Mn <sub>2</sub> O <sub>3</sub>	Manganese oxide	N	Normal (e.g., 1N H <sub>3</sub> PO <sub>4</sub> is 1 normal solution of phosphoric acid)
M-N-H	Amide/imide	N	Nitrogen atom
MnO	Manganese oxide	N	Newton (unit of force)
mΩ	Milli-ohm(s)	N112	Nafion® 1100 equivalent weight, 2 millimeter thick membrane
MΩ	Mega-ohm(s)	N <sub>2</sub>	Diatomic nitrogen
mΩ/cm <sup>2</sup>	Milli-ohm(s) per square centimeter	N <sub>2</sub> O	Nitrous oxide
μΩ-cm <sup>2</sup>	Micro-ohm(s) - square centimeter	Na	Sodium
Mo	Molybdenum	NA	North American
MOF	Metal-organic framework	Na <sub>2</sub> S	Sodium sulfide
mol	Mole(s)	Na <sub>3</sub> AlH <sub>6</sub>	Trisodium hexahydroaluminate
mol%	Mole percent	NaAlH <sub>4</sub>	Sodium aluminum hydride; sodium tetrahydroaluminate; sodium alanate
mol/min	Mole(s) per minute	NaBH <sub>4</sub>	Sodium borohydride
MOR	Methanol oxidation reaction	NaBO <sub>2</sub>	Sodium metaborate
MPa	Megapascal (s)	NaCl	Sodium chloride
MPG, mpg	Mile(s) per gallon	Nafion®	Registered Trademark of E.I. DuPont de Nemours
MPGGE	Miles per gasoline gallon equivalent	NaH	Sodium hydride
mph	Mile(s) per hour	NA NG	North American natural gas
MPL	Microporous layer	NaOH	Sodium hydroxide
mpy	Mils per year	NAS	National Academy of Sciences
MR	Membrane reactor		
MRI	Magnetic resonance imaging		
MRL	Manufacturing readiness level		
ms	Millisecond(s)		
MS	Mass spectroscopy, mass spectrometry		
MSAC	Mid-range carbon support		
mS/cm	Milli-Siemen(s) per centimeter		

#### XIV. Acronyms, Abbreviations and Definitions

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NASA	National Aeronautics and Space Administration	NNA NG	Non-North American natural gas
NASCAR	National Association for Stock Car Auto Racing	NNIF	NIST neutron imaging facility
Nb	Niobium	NMOC	Non-methane organic carbons
N/cm <sup>2</sup>	Newton(s) per square centimeter	NO <sub>2</sub>	Nitric oxide
NCCC	National Carbon Capture Center	NO <sub>x</sub> , NO <sub>x</sub>	Oxides of nitrogen
NCSL	National Conference of State Legislators	NP	Nanoparticle
ND	Not determined at this time	NPC	Nanoporous carbon; normalized photocurrent
NDA	Non-disclosure agreement	NPD	Neutron powder diffraction
NDC	New delivery concept, Naphthalene-2,6-dicarboxylate	NPGM	Non-precious metal group
NDE	Non-destructive examination	NPMC	Non-precious metal catalyst
NDP	Neutron depth profiling	NFPA	National Fire Protection Association
NDTE	Non-destructive testing and evaluation	NPM	Non-precious metal
NEB	Nudged elastic band	NPS	National Park Service
NEED	National Energy Education Development Project	NPT	Normal pressure and temperature
NE ISO	New England Independent System Operator	NPV	Net present value
NEMS	National Energy Modeling System	NR	Nanorod
NEPA	National Environmental Policy Act	NREL	National Renewable Energy Laboratory
NETL	National Energy Technology Laboratory	NRELFAT	NREL Fleet Analysis Toolkit
NFC	Near-frictionless coating	NSF	National Science Foundation
NFCRC	National Fuel Cell Research Center	NST	New stress test
NFM	Nanoporous framework material	NSTF	Nano-structured thin-film
NFPA	National Fire Protection Association	NT	Nanotube
ng	Nanogram	NTCNA	Nissan Technical Center, North America
NG	Natural gas	NVS	Neutron vibrational spectroscopy
NGV	Natural gas vehicle	NY ISO	New York Independent System Operator
NH <sub>3</sub>	Ammonia	Ω	Ohm(s)
NHE	Normal hydrogen electrode	Ωcm <sup>2</sup>	Ohm(s) - square centimeter
NHI	Nuclear Hydrogen Initiative	O	Oxygen
Ni	Nickel	O <sub>2</sub>	Diatomic oxygen
NiMH	Nickel metal hydride	O/C	Oxygen-to-carbon ratio
NIR	Near infra-red	OCP	Open circuit potential
NIST	National Institute of Standards and Technology	OCV	Open-circuit voltage
NL	Normal liter(s)	o.d.,OD	Outer diameter
nm	Nanometer(s)	OEM	Original equipment manufacturer
NM	Noble metal	OER	Oxygen evolution reaction
Nm <sup>3</sup>	Normal cubic meter(s)	OGMC	Ordered graphitic mesoporous carbon
NMHC	Non-methane hydrocarbons	OH	Hydroxyl radical
nmol	Nanomole(s)	O&M	Operation and maintenance
NMR	Nuclear magnetic resonance	OMC	Ordered mesoporous carbon
NMSU	New Mexico State University	OML	Outer mold line
NMT	New Mexico Tech	ORNL	Oak Ridge National Laboratory
NNA	Non-North American	ORNL-HTML	Oak Ridge National Laboratory High Temperature Materials Laboratory
		ORR	Oxygen reduction reaction
		OSC	Oxygen storage capability

OSM	Oregon Steel Mills, Optical scatterfield microscopy	PEM	Proton exchange membrane, Polymer electrolyte membrane
OSU	Ohio State University	PEMFC	Polymer electrolyte membrane fuel cell
OTM	Oxygen transport membrane	PEMFC	Proton exchange membrane fuel cell
P	Phosphorus	PEO	Poly(ethylene oxide)
P	Pressure	PES	Polyethersulfone
Pa	Pascal(s)	PET	Polyethylene terephthalate
PA	Phenylacetylene, Polyamide	PFA	Polyfurfuryl alcohol
PAA	Poly(acrylic acid)	PFD	Process flow diagram
PAD	Polymer assisted deposition	PFIA	Perfluoro imide acid
PAES	Poly(arylene-ether-sulfone)	PFPO	Perfluorinated propylene oxide
PAF	Porous aromatic framework	PFSA	Perfluorinated sulfonic acid, perfluorosulfonic acid, poly(fluorosulfonic acid)
PAFC	Phosphoric acid fuel cell		
PAN	Peroxyacetyl nitrate, polyacrylonitrile		
PANI	Polyaniline	PFSHQ	2-(5-fluorosulfonyl-3-oxaocetafluoropentyl)-1,4-dihydroxy-benzene
PAS	Photoactive semiconductor		
Pb	Lead	PGE	Platinum group element
PB	Polyborazylene	PG&E	Pacific Gas and Electric Company
PbA	Lead acid	PGM	Precious group metal, Platinum group metal
PBI	Polybenzimidazole	PGV	Puna Geothermal Ventures
PbO	Lead oxide	pH	Power of the hydronium ion
PC	Polycarbonate	<i>p</i> -H <sub>2</sub>	Para-hydrogen
PC	Personal computer	PHEV	Plug-in hybrid vehicle
PCA	Pyrenecarboxylic acid	PHS	Pumped hydro storage
PCE	Perchloroethylene	PI	Principal investigator
PCI	Pressure-composition isotherm	PI	Polyimide
PCL	Polycaprolactone	P&ID	Piping and instrumentation diagram, process and instrumentation diagram
PCM	Power control module		
PCR	Polymerase chain reaction	PIL, pIL	Protic ionic liquid
PCT, P-C-T	Pressure-concentration-temperature	PIM, pIM	Protic ionic membrane
PCTFE	Polychlorotrifluoroethylene	pK <sub>a</sub>	Acid dissociation constant
Pd	Palladium	PLC	Programmable logic controller
PD	Pressure decay	PLRS	Planar laser Raleigh scatter
PdAg	Palladium-silver alloy	PM	Particulate matter
Pd-CR	Palladium-based chemical resistor	PNNL	Pacific Northwest National Laboratory
PdCu, Pd-Cu	Palladium-copper alloy	pO <sub>2</sub>	Oxygen partial pressure
PdCuTM	Palladium copper transition metal	POC	Proof of concept
PDF	Probability density function	POF	Polymeric-organic frameworks; Porous organic framework
PDMS	Polydimethylsiloxane		
PDU	Process development unit	POP	Porous organic polymers
PEEK	Polyether ether ether ketone	POSS	Polyhedral oligomeric silsesquioxane
PEFC	Polymer electrolyte fuel cell	POX	Partial oxidation
PEFC	Proton exchange fuel cell	PP	Polyphosphazene, polypropylene, poly(phenylene)
PEG	Polyethylene glycol		
PEGS	Prototype electrostatic ground state	PPA	polyphosphoric acid; polyphthalamide
PEI	Polyetherimide, polyethylene imine	ppb	Part(s) per billion
PEKK	Poly (ether ketone ketone)	ppbv	Part(s) per billion by volume

#### XIV. Acronyms, Abbreviations and Definitions

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PPDSA	Poly (p-phenylene disulfonic acid)	PTW	Pump-to-wheels
PPI	Pore(s) per inch	PV	Photovoltaic; present value
ppm, PPM	Part(s) per million	PVA	Polyvinyl alcohol
ppmv	Part(s) per million by volume	PVC	Polyvinyl chloride
ppmw	Part(s) per million by weight	PVD	Physical vapor deposition
PPN	Porous polymer network	PVDC	Poly-vinylidene chloride
PPOR	Metalloporphyrin porous organic polymer	PVDF	Polyvinylidene fluoride
P-POSS	Phosphonic acid polyhedral oligomeric silsesquioxane	PVL	Print verification line
PPS	Polyphenylene sulfide	PVP	Polyvinylpyrrolidone
PPSA	Poly (p-phenylene sulfonic acid)	PVPP	Polyvinyl pyridinium phosphate
PPSA	Partial pressure swing adsorption	PVT, P-V-T	Pressure-Volume-Temperature
PPSU	Polyphenylsulfone	PXRD	Powder X-ray diffraction
PRD	Pressure relief device	Q	Neutron momentum transfer
PRO	Pressure retarded osmosis	Q1, Q2, Q3, Q4	Quarters of the fiscal year
PSA	Pressure swing adsorption, adsorber	QC	Quality control
PSAT	Powertrain Systems Analysis Toolkit, a vehicle simulation software package developed at Argonne National Laboratory	QCM	Quartz crystal microbalance
PSD	Particle size distribution, pore size distribution	QE	Quantum efficiency
PSEPVE	Perfluoro (4-methyl-3,6-dioxaoct-7-ene) sulfonyl fluoride	QENS	Quasielastic neutron scattering
PSf	Poly(arylene ether sulfone)	QFD	Quality function deployment
psi, PSI	Pound(s) per square inch	QLRA	Qualitative risk analysis
PSI	Photosystem I	QMC	Quantum Monte Carlo
psia	Pound(s) per square inch absolute	QNS	Quasielastic neutron scattering
psid	Pound(s) per square inch differential	QRA	Quantitative risk assessment
psig, PSIG	Pound(s) per square inch gauge	R	Universal or ideal gas constant, $8.314472 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$
PSII	Photosystem II	RAMAN	A spectroscopic technique
PSM	Protic salt membrane	R&D	Research and development
PSOFC	Planar solid oxide fuel cell	RD&D, R,D&D	Research, development & demonstration
PSS	Porous stainless steel, potentiostatic scan	RDE	Rotating disk electrode
PSU	Polysulfone	Re	Rhenium
PSU	Pennsylvania State University	Rf	Generic fluoroalkyl group
Pt	Platinum	RF, rf	Radio frequency
P-T	Pressure-temperature	RF	Roughness factor
Pt <sub>3</sub> Co	Platinum-cobalt alloy	RFP	Request for proposals
Pt <sub>3</sub> Fe	Platinum-iron alloy	RGA	Residual gas analyzer (analysis)
Pt <sub>3</sub> Ni	Platinum-nickel alloy	Rh	Rhodium
PTA	Phosphotungstic acid	RH	Relative humidity
Pt/C	Platinum/carbon	RHE	Reference hydrogen electrode; reversible hydrogen electrode
PTFE	Teflon <sup>®</sup> – poly-tetrafluoroethylene	RNA	Ribo nucleic acid
Pt-FePO	Platinum iron phosphate	RNG	Renewable natural gas
PtO	Platinum oxide	RO	Reverse osmosis
PtO <sub>2</sub>	Platinum dioxide	ROM	Rough order of magnitude
PtRu	Platinum ruthenium	RPC	Ruthenium-polyridyl complex
		RPI	Rensselaer Polytechnic Institute

rpm	Revolution(s) per minute	SECA	Solid State Energy Conversion Alliance
RPS	Renewable portfolio standard	SEDS	State Energy Data System
RRC	Regional resource center	SEM	Scanning electron microscopy, scanning electron microscope
RRDE	Rotating ring disc electrode	SEM	Secondary electron microscopy
RRW	Risk reduction worth	SEPUP	Science Education for Public Understanding Program
RSA	Random sequential adsorption	SERA	Scenario Evaluation, Regionalization and Analysis
RSOFC	Reversible solid oxide fuel cell	SET	Surface Energy Treatment
RT	Room temperature	SF	Polystyrene-b-PFPO
RTD	Resistive thermal device	SF <sub>6</sub>	Sulfur hexafluoride
Ru	Ruthenium	SFA	Sulfonic acid
s	Second(s)	SFO	San Francisco International Airport
S	Siemen(s)	SGD	Spontaneous galvanic displacement, system gravimetric density
S	Sulfur	SHE	Standard hydrogen electrode
SA	Specific amperage	Si	Silicon
SA	Sulfur-ammonia thermochemical water-splitting cycle	S-I	Sulfur-iodine
SAC	Site acquisition	SI	Sulfur-iodine cycle; spectrum image
SAE	SAE International, originally known as the Society of Automotive Engineers	Si <sup>3</sup> N <sup>4</sup>	Silicon nitride
SAFC	Solid acid fuel cell	SiC	Silicon carbide
SAH	Sodium aluminum hydride	SiCN	Silicon carbonitride
SAM	Scanning Auger microscopy	SIMS	Secondary ion emission spectroscopy
SANS	Small angle neutron scattering	SiO <sub>2</sub>	Silicon dioxide
SAXS	Small angle X-ray scattering	SIU	Southern Illinois University
S <sub>BET</sub>	BET specific surface area	sL	Standard liter (0°C, 1 atm)
SBIR	Small Business Innovation Research	SLD	Simplified local density
SBTS	Stack Block Test System	slpm, slm, sL/min	Standard liter(s) per minute
SBU	Secondary building unit	SMR	Steam methane reformer; steam methane reforming
Sc	Scandium	Sn	Tin
S/C	Steam to carbon ratio	SNL	Sandia National Laboratories
sccm, SCCM	Standard cubic centimeter(s) per minute	SNR	Signal-to-noise ratio
SCE	Saturated calomel electrode	SNTT	Spiral notch torsion test
SCF, scf	Standard cubic feet, supercritical fluid	SLAC	Stanford Linear Accelerator Center
scfd	Standard cubic feet per day	SLPH	Standard liter(s) per hour
SCFH, scfh	Standard cubic feet per hour	SLPM	Standars liter(s) per minute
SCFM	Standard cubic feet per minute	SLT	Strontium-doped lanthanum titanate
S/cm	Siemen(s) per centimeter	SnO	Tin oxide
SCOF	Single cell with open flowfield	SnO <sub>2</sub>	Tin oxide
SC-PC	Supercritical pulverized coal	SO <sub>2</sub>	Sulfur dioxide
SCR	Selective catalytic reduction	SO <sub>3</sub>	Sulfur trioxide
SCS	Solution combustion synthesis	SOC	State-of-charge
SCT-MAT	Short Circuit MicroActivity Testing	SOEC	Solid oxide electrolysis cell; solid oxide electrolyzer cell
SD	Standard deviation, System dynamics	SOFC	Solid oxide fuel cell
SDO	Standards development organization		
Se	Selenium		
sec	Second(s)		
SEC	Size exclusion chromatography		

#### XIV. Acronyms, Abbreviations and Definitions

SOFEC	Solid oxide fuel-assisted electrolysis cell	t	Time
SOx	Oxides of sulfur	$T_{1\text{bar}}$	Temperature at which equilibrium pressure of hydrogen is 1 bar for a hydrogen exchange reaction
sPAES	Sulfonated poly(arylene ether sulfone)		
SPEEK	Sulfonated poly(ether ether ketone)	Ta	Tantalum
SPEK	Sulfonated poly-etherketone-ketone	TAG	Technical Advisory Group
SPEKK	Sulfonated polyether(ether ketone ketone)	TBAB	Tetra- <i>n</i> -butylammonium bromide
SPEX	Type of milling machine	$TBA_2B_{12}H_{12}$	Tetra- <i>n</i> -butylammonium dodecahydrododecaborate
SPM	Scanning probe microscope	TBABh	Tetra- <i>n</i> -butylammonium borohydride
sPOSS	sulfonated octaphenyl polyhedral oligomeric silsesquioxanes	TBA-PF <sub>6</sub>	Tetra- <i>n</i> -butylammonium hexafluorophosphate
sq. in.	Square inch(es)	TBD	To be determined
Sr	Strontium	TC	Thermocouple
SR	Steam reformer; steam reforming	TC	Transparent conducting
SR-M	Steam reformer membrane	TCCR	Transparent, conducting and corrosion resistant
SRNL	Savannah River National Laboratory	TCD	Thermal conductivity detector
SrO	Strontium oxide	TCO	Transparent conductive oxide
SrTiO <sub>3</sub>	Strontium titanate, the proton conducting material	Te	Tellurium
SS	Stainless steel	te	Metric ton or tonne (1,000 kg)
SSA	Specific surface area	TEA	Triethylamine
SSAWG	Storage System Analysis Working Group	TEAA	Triethylamine alane adduct
SSR	Solid-state reaction	TEDA	Triethylenediamine
SSWAG	Storage System Working Analysis Group	TEM	Transmission electron microscopy
STCH	Solar Thermochemical Hydrogen	TEOA	Triethanolamine
STEM	Scanning transmission electron microscopy	TEOM	Tapered element oscillating microbalance
STEM	Science, technology, engineering, and mathematics	tf	Thin film
STH	Solar-to-hydrogen	TFE	Tetrafluoroethylene
STM	Scanning tunneling microscopy	TF-RDE:	Thin film rotating disk electrode
STMBMS	Simultaneous thermogravimetric modulated beam mass spectrometer	tf-Si	Thin-film silicon
STP	Standard temperature and pressure	TFVE	Trifluorovinyl ether
STS	Scanning tunneling spectroscopy	TGA	Thermal gravimetric analysis; thermogravimetric analysis; thermogravimetric analyzer
STTP	Shared Technology Transfer Project	TGA-DSC	Thermo-gravimetric analysis-differential scanning calorimetry
STTR	Small Business Technology Transfer	TGA-MS	Thermogravimetric analysis-mass spectrometer
SU/SD	Start-up and shut-down	THF	Tetrahydrofuran
SV	Space velocity	Ti	Titanium
SVD	System volumetric density	TiCl <sub>3</sub>	Titanium trichloride
SWCNT	Single-walled carbon nanotube	TiF <sub>3</sub>	Titanium trifluoride
SWNH	Single-walled nanohorn	TiH <sub>2</sub>	Titanium hydride
SWNT	Single-wall nanotube	Ti-IRMOF-16	Titanium (Ti) intercalated IRMOF-16
SwRI®	Southwest Research Institute	TIO	Technology improvement opportunities
S <sub>y</sub>	Yield strength	TiO <sub>2</sub>	Titanium dioxide (anatase)
SYT	Yttrium-doped strontium titanate	TKK	Tanaka Kikinzoku Kogyo K. K.
T	Temperature		
T, t	Ton, tonne		
T	Tesla (unit of magnetic induction)		



<i>Tla</i>	Truncated light-harvesting chlorophyll antenna	UHV	Ultra-high vacuum
<i>tla1</i>	Mutant of the Tla1 gene (GenBank Assession No. AF534570)	UIUC	University of Illinois, Urbana-Champaign
<i>tlaR</i>	Mutant of unknown gene with a truncated light-harvesting chlorophyll antenna	UL	Underwriters Laboratory
<i>tlaX</i>	Mutant of unknown gene with a truncated light-harvesting chlorophyll antenna	ULSD	Ultra-low sulfur diesel
TM	Transition metal	um	Micrometer(s)
TMA	Thermal mechanical analyzer	UMC	Unsaturated metal centers
TMB	Trimethylborate	UNCC	University of North Carolina at Charlotte
TMEDA	Tetramethylethane-1,2-diamine; $N^1, N^1, N^2, N^2$ -tetramethylethane-1,2-diamine	UNLV	University of Nevada, Las Vegas
TMF	The Molecular Foundry	UNLVRF	UNLV Research Foundation
TMG	Tetramethyl guanidine	UNM	University of New Mexico
TMM	Thermal management module	UNR	University of Nevada, Reno
TMPyP	Tetramethylpyridylporphine	UPD	Underpotentially deposited
TNT	Trinitrotoluene	UPE	Ultra-high molecular weight polyethylene
TOC	Total organic content	UPL	Upper potential limit
TOF	Turnover frequency	UPS	Ultraviolet photoelectron spectroscopy
TON	Turnover number	U.S.	United States
TPA	Tripropylamine, Temperature-programmed adsorption	US06	Environmental Protection Agency vehicle driving cycle
TPB	Triple phase boundary	USA	United States of America
TPD	Tonne(s) per day	USANS	Ultra small angle neutron scattering
TPD	Thermally programmed desorption; Temperature-programmed desorption	USB	Universal serial bus
TPO	Temperature-programmed oxidation	USC	University of South Carolina
TPR	Temperature-programmed reduction	USC	University of Southern California
TPV	Through plate voltage	USCAR	United States Council for Automotive Research, U.S. Cooperative Automotive Research
TR	Traditional reactor	USFCC	United States Fuel Cell Council
TRAIN	TrainingFinder Realtime Affiliate Network	USGS	United States Geological Survey
TRL	Technology readiness level	USM	University of Southern Mississippi
tr. oz.	Troy ounce	UT	University of Tennessee
TSA	Temperature swing adsorption	UTC	University of Tennessee, Chattanooga
TV	Test vehicle	UTCP	UTC Power
UC	University of California	UTRC	United Technologies Research Center
UCB	University of California, Berkeley	UV	Ultraviolet
UCF	University of Central Florida	UV-vis	Ultraviolet-visual
UCI	University of California, Irvine	V	Vanadium
UCLA	University of California, Los Angeles	V	Volt
UCONN	University of Connecticut	VA	Vinyl acetate
UCSB	University of California, Santa Barbara	VAC	Volts alternating current
UDDS	Urban Dynamometer Driving Schedule	VACNTs	Vertically aligned carbon nanotubes
UEL	Upper explosive limit	VANTA	Vertically aligned nanotube arrays
UFL	Upper flammability limit	VASP	Vienna ab initio simulation package
UH	University of Hawaii	VB	Valence band
UHP	Ultra-high purity	VBM	Valence band minimum
		VBM	Valence band maximum
		VC	Vanadium carbide
		VC	Vulcan carbon

#### XIV. Acronyms, Abbreviations and Definitions

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VDC	Volts direct current	WO <sub>3</sub>	Tungsten trioxide
VDF	Vinylidene fluoride	Wppm	Weight part(s) per million
VDOS	Vibrational density of states	wt	Weight
vdW	van der Waals	Wt	Watt(s) thermal
VI	Venter Institute	wt%, wt. %	Weight percent (percent by weight)
V-I	Voltage – current	WTP	Well-to-pump
VIR	Voltage-current-resistance	WTP	Water transport plate
V <sub>mp</sub>	Micropore volume	WTT	Well-to-tank
VMT	Vehicle miles travelled	WTW	Well-to-wheels
VNT	Variable nozzle turbine	w/v	Weight by volume
VOC	Volatile organic compound	WWTP	Waste water treatment plants
VOC	Voltage open circuit	XAFS	X-ray absorption fine structure
vol	Volume	XANES	X-ray absorption near-edge spectroscopy
vol%	Volume percent	XAS	X-ray absorption spectroscopy
V <sub>pore</sub>	Total pore volume	XC72	High-surface-area carbon support made by Cabot
VRB	Vanadium-redox battery	XES	X-ray emission spectroscopy
W	Tungsten	XPS	X-ray photoelectron spectroscopy, X-ray photon spectroscopy, X-ray photoemission spectroscopy, X-ray photoluminescence spectroscopy
W	Watt(s)	XRD	X-ray diffraction
WAXD	Wide-angle x-ray diffraction	XRF	X-ray fluorescence
WAXS	Wide angle X-ray scattering	Y	Yttrium
WC	Tungsten carbon, tungsten carbide	yr, YR	Year
W/cm <sup>2</sup>	Watt(s) per square centimeter	YSZ	Yttria-stabilized zirconia
W <sub>e</sub>	Watt(s) electric	ZEV	Zero emission vehicle
WECC	Western Electric Coordinating Council	ZHS	Zinc hydroxystannate
WGS	Water-gas shift	ZIF	Zeolitic imidazolate framework
WGSR	Water-gas shift reactor	Zn	Zinc
WGSMR	Water-gas shift membrane reactor	ZnO	Zinc oxide
Wh	Watt-hour(s)	Zr	Zirconium
W(H <sub>2</sub> )	Gravimetric hydrogen storage capacity	ZrO <sub>2</sub>	Zirconium dioxide
W-h/kg	Watt-hour(s) per kilogram	ZrSPP	Zirconium phosphate sulfophenylphosphonate
W-h/L, Wh/liter, Wh/L	Watt-hour(s) per liter	ZVI	Zerovalent iron
WHSV	Weight hourly space velocity		
Wind2H2	Wind to hydrogen demonstration project		
W/kg	Watt(s) per kilogram		
W/L, W/l	Watt(s) per liter		
W/m-K, W/m.K, W/mK	Watt(s) per meter-Kelvin (unit of thermal conductivity)		