

XII. Acronyms, Abbreviations and Definitions

°C	Degrees Celsius	$\mu\text{A}/\text{cm}^2$	Micro ampere(s) per square centimeter
°F	Degrees Fahrenheit	μg	Microgram(s)
Δ	Change, delta	μm	Micrometer(s); micron(s)
~	Approximately	μM	Micromolar
\approx	Equals approximately	μmol	Micromole(s)
>	Greater than	$\mu\Omega\text{-cm}^2$	Micro-ohm(s) - square centimeter
\geq	Greater than or equal to	μV	Micro volt(s)
"	Inch(s)	Ω	Ohm(s)
\leq	Less than or equal to	$\Omega\text{-cm}^2$	Ohm-square centimeter
<	Less than	A	Ampere, amps
#	Number	Å	Angstrom
%	Percent	A_0	Arrhenius constant, $\text{ml}/(\text{cm}^2\text{-min-atm}^{1/2})$
®	Registered trademark	AAO	Anodic aluminum oxide
\$	U.S. Dollars	AB	Ammonia borane, NH_3BH_3
1-D, 1D	One-dimensional	ABH_2	Ammonium borohydride, NH_4BH_4
2-D, 2D	Two-dimensional	ABI	Automated ball indentation; agent-based investment
2-FPTf	2, fluoropyridinium triflate		
3-D, 3D	Three-dimensional	ABM	Agent-based modeling
1Q	First quarter of the fiscal year	ABMS	Agent-based modeling and simulation
2Q	Second quarter of the fiscal year	ABPBI	Poly(2,5-benzimidazole)
3Q	Third quarter of the fiscal year	AC	Activated carbon; air-cooled; alternating current
4Q	Fourth quarter of the fiscal year		
6F	Hexafluorinated (biphenol A) sulfonated poly(arylene ether sulfone)	A/C	Anode/cathode
6FCN-x	HexaFluoro bisphenol A based disulfonated polybenzoxirle (H+ form) (x denotes degree of sulfonation)	ACF	Activated carbon fibers
6FK	Partially fluorinated poly(arylene ether ketone)	A/cm^2	Amps per square centimeter
6F-x	HexaFluoro bisphenol A based disulfonated polySulfone (H+ form) (x denotes degree of sulfonation)	ACN	Acetonitrile
8YSZ	8 mol% yttria-stabilized zirconia	ACR	Autothermal cyclic reforming
$^{11}\text{B-NMR}$	Boron 11 nuclear magnetic resonance	ACS	American Chemical Society
$^{19}\text{FNMR}$	19 Fluorine nuclear magnetic resonance	AC Transit	Alameda-Contra Costa Transit
$\alpha\text{-AlH}_3$	Alpha polymorph of aluminum hydride	AE	Alkaline earth
ΔB_a	The difference in magnetic induction at high and low applied magnetic fields	AECL	Atomic Energy Canada, Limited
ΔG	Gibbs free energy of reaction	AEO	Annual Energy Outlook
ΔH	Enthalpy of reaction, Enthalpy of hydrogenation	AER	Absorption-enhanced reforming; all-electric range
ΔH_f°	Standard heat of formation	AES	Auger electron spectroscopy
ΔP	Pressure drop, pressure change	AFB	Airfoil bearing
λ	Lambda, hydration number	AFM	Atomic force microscopy; anti-ferromagnetic
μA	Micro ampere(s)	AFP	Automated fiber placement
		AFV	Alternative fuel vehicle
		Ag	Silver
		AgCl	Silver chloride
		A-h	Amp-hour
		AIBN	Azobisisobutyl nitrile

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AIChE	American Institute of Chemical Engineers	ATP	Adenosine triphosphate
AISI	American Iron & Steel Institute	ATPase	Adenosine triphosphatase
AK	Alkali	ATR	Autothermal reformer; autothermal reforming; attenuated total reflection
Al	Aluminum	ATR-FTIR	Attenuated total reflectance Fourier transform infrared
Al*	Aluminum particles catalyzed with titanium	Au	Gold
Al ₂ O ₃	Aluminum oxide	a.u.	Arbitrary units
Al-AB	Aluminum ammonia-borane	AuS	Gold sulfide
AlCl ₃	Aluminum chloride	AuSnO _x	Gold supported on hydrous tin oxide
ALD	Atomic layer deposition	AuTiO _x	Gold supported on titanium oxide
AlH ₃	Aluminum hydride; alane	Avg	Average
ALS	Advanced Light Source at Lawrence Berkeley National Laboratory	ΔB _a	The difference in magnetic induction at high and low applied magnetic fields
AM 1.5	Air Mass 1.5 solar illumination	B	Boron
AMBH	Ammine metal borohydride	B ₂ O ₃	Boron oxide; diboron trioxide
AMR	Annual merit review; active magnetic regenerator	Ba	Barium
AMRL	Active magnetic regenerative liquefier	BAC	Bond additivity correction
ANL	Argonne National Laboratory	barg	Bar gauge
ANS	American Nuclear Society	bcc	Body-centered cubic
ANSI	American National Standards Institute	BCN	Boron carbon nitride
A ₀	Arrhenius constant, ml/(cm ² -min-atm ^{1/2})	BCP	Block copolymers
AP	Advanced prototype	BDC	Benzenedicarboxylate
AP	Anode polarization	BDS	Broadband dielectric spectroscopy
APC	Adaptive process control	Be	Beryllium
APCI, APCi	Air Products and Chemicals, Inc.	BeD-XRD	Beryllium dome X-ray diffraction
APR	Aqueous-phase reforming	BES	Basic Energy Sciences office within the DOE Office of Science
APRxn	Aqueous phase reaction	BET	Brunauer-Emmett-Teller surface area analysis method
APU	Auxiliary power unit	B-G	Boron-doped graphitic material
Ar	Argon	B-H	Borohydride; boron/hydrogen bond
Arb, arb.	Arbitrary	BH ₄	Borohydride
ARET	Alternative and renewable energy technologies	Bi	Bismuth
As	Arsenic	BILI	Bio-derived liquid fuels
a-Si	Amorphous silicon	BisSF	Bisphenol-Sulfone
a-SiC	Amorphous silicon carbide	BM	Ball-milled; ball mill
a-SiGe	Amorphous silicon germanium	BMG	Bulk metallic glasses
ASM	American Society of Metals	bmimBF ₄	1-butyl-3-methyl-imidazolium tetrafluoroborate
ASME	American Society of Mechanical Engineers	bmimCl	1-butyl-3-methyl-imidazolium chloride
ASPEN	Modeling software, computer code for process analysis	BmimOTf	1-butyl-3-methyl-imidazolium triflate
ASR	Area-specific resistance	bmimPF ₆	1-butyl-3-methyl-imidazolium hexafluorophosphate
ASTM	ASTM International	BMPFFP	1-butyl-1-methyl-pyrrolidinium tris(pentafluoroethyl)trifluorophosphate
AT	Ammonia triborane	BN	Boron-nitrogen
at%	Atomic percent	BNHx	Dehydrogenated ammonia-borane
atm	Atmosphere		

BNL	Brookhaven National Laboratory	C ₃ H ₈	Propane
BNNT	Boron nitride nanotubes	C&S	Codes and Standards
B-O	Any oxidized boron species, borate	Ca	Calcium
Boc	Tert-butoxycarbonyl	CA	Carbon aerogel
B(OH) ₃	Boric acid	CaBr ₂	Calcium bromide
BOL	Beginning of life	CaCO ₃	Calcium carbonate
BOMD	Born-Oppenheimer Molecular Dynamics	CAD	Computer-aided design
BOP, BoP	Balance of plant	CAE	Computer-assisted engineering
¹¹ B-NMR	Boron 11 nuclear magnetic resonance	CaFCP	California Fuel Cell Partnership
BP	Formerly British Petroleum, British Petroleum America Production Company	CAFE	Corporate Average Fuel Economy
BPDC	Biphenyldicarboxylate	CaI	<i>Clostridium acetobutylicum</i> hydrogenase
bpe	Bis(4-pyridyl)ethane	CALPHAD	Calculation of phase diagrams
BPEE	1,2-bipyridylethene	Caltech	California Institute of Technology
BPP	Bipolar plate	CaO	Calcium oxide
BPPPO	Biphenol-based phenyl phosphine oxide	CARB	California Air Resources Board
BPPPO-35	Biphenol-based phenyl phosphine oxide copolymer, 35% molar fraction of disulfonic acid unit (35% level of sulfonation)	CaS	Calcium sulfide
BPS	Ballard Power Systems; bi phenyl sulfone	CBM	Conduction band minimum
BPS100	Fully disulfonated poly(arylene ether sulfone)	CBN	Carbon-boron-nitrogen
BPSH	Block polysulfone ether polymers; bi phenyl sulfone: H form	CBS	Casa Bonita strain; complete basis set
BPSH-x	BiPhenyl based disulfonated polySulfone (H+ form) (x denotes degree of sulfonation)	cc	Cubic centimeter(s)
BPSH-30	Biphenyl sulfone H form, 30% molar fraction of disulfonic acid unit (30% level of sulfonation)	CCA	Charge control agent
BPVE	Perfluorocyclobutane-biphenyl vinyl ether	CCAT	Connecticut Center for Advanced Technology, Inc.
BPVE-6F	Perfluorocyclobutane-biphenyl vinyl ether hexafluoroisopropylidene	CCD	Charge-coupled device
BPY	2,2'-bipyridine	cCH ₂	Cryo-compressed hydrogen
BPY	4,4'-bipyridine	CCM	Catalyst-coated membrane; coordinate measuring machine
Br	Bromine	cc/min	Cubic centimeters per minute
Br ₂	Diatomic bromine	ccp	Cubic close-packing
BSC	Bi-electrode supported cell	CCSD(T)	Coupled cluster theory with single and double excitations plus a perturbative correction for triple excitations
BTB	1,3,5-benzenetribenzoate	Cd	Cadmium
BTU, Btu	British thermal unit(s)	CD	Compact disk; charge depleting; cathode dewpoint
Bu ₃ SnCl	Tributyltin chloride	CDC	Carbide-derived carbon
Bu ₃ SnSnBu ₃	Hexabutyldistannane	cDNA	Complementary DNA
BV	Benzyl viologen	CDO	Code development organization
BxHy	Polyhedral boranes	CDP	Composite data product
C	Carbon; Coulomb; coulomb	CdS	Cadmium sulfide
C ₂ H ₄	Ethylene	Ce	Cerium
C ₂ H ₆	Ethane	CEA	Commissariat à l'Énergie Atomique
		CEMM	Compressor-expander motor module
		CeO ₂	Ceric oxide
		CEQA	California Environmental Quality Act
		CF	Carbon fiber; carbon foam
		CFC	Chlorofluorocarbon

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CFCC	Colorado Fuel Cell Center	COS	Carbon oxysulfide; carbonyl sulfide
CFD	Computational fluid dynamics	COSMO/RS	COnductor like Screening MOdel for Realistic Solvents (computational method)
CFM, cfm	Cubic feet per minute	CoT	City of Taylor
CGM	Charge-generating material	CoTMPP	Cobalt tetramethoxyphenyl porphyrin
CGO	Cerium gadolinium oxide, Gd-doped CeO ₂	CoTPP	Cobalt tetraphenyl porphyrin
CGS	Copper gallium diselenide	COx	Oxides of carbon
CGSe ₂	Copper gallium diselenide	c _p	Specific heat
CH	Hydrogenated graphene	CPO	Coordination polymer Oslo
CH ₂	Compressed hydrogen gas	CPO, CPOX	Catalytic partial oxidation
CH ₄	Methane	CP-Ti	Commercially pure titanium
CHHP	Combined heat, hydrogen, and power	CPU	Computer processing unit
Chl	Chlorophyll	Cr	Chromium
CHP	Combined heat and power	CRBJT	Combined reverse-Brayton Joule-Thompson
CHSCoE	Chemical Hydrogen Storage Center of Excellence	CRW	Clipped random wave
CI	Compression ignition	Cs	Cesium
CIGS	Copper indium gallium diselenide	CS	Charge sustaining
CIGSe ₂	Copper indium gallium diselenide	CSA	Canadian Standards Association; cell stack assembly
CIRRUS	Cell Ice Regulation & Removal Upon Start-up	CSD	Compression-storage-delivery
CIS	CuInSe (alloy of copper, indium, and selenium)	CSM	Colorado School of Mines; combined structure & material
Cl	Chlorine	CSR	Catalytic steam reforming; compressive stress relaxation
cm	Centimeter	CT	Compact tension
cm ²	Square centimeter	CTA	Charge transfer agent
CMAQ	Community multiscale air quality	CTC	Concurrent Technologies Corporation
CMO	Conductive metal oxides	CTE	Coefficient of thermal expansion
CMR	Composite membrane reactor	CTFE	Chlorotrifluoroethylene
CMS	Carbon molecular sieve	CTTRANSIT	Connecticut Transit
CMU	Carnegie Mellon University	CTV	Chevron Technology Ventures LLC
CMWNT	Carbon multi-walled nanotube	Cu	Copper
CN	Carbon-nitrogen	Cu ₂ O	Cuprous oxide
CNG	Compressed natural gas	CU	University of Colorado
CNM	Crystalline nanoporous material	cu. in.	Cubic inch
CNMS	Center for Nanophase Materials Sciences	CUMC	Coordinatively unsaturated metal centers
CNT	Carbon nanotube	CuO	Cupric oxide, copper(II) oxide
Co	Cobalt	CV	Cyclic voltammetry; cyclic voltammogram
CO	Carbon monoxide	CVD	Chemical vapor deposition
CO ₂	Carbon dioxide	CVS	Chemical vapor synthesis
COD	Chemical oxygen demand	CWRU	Case Western Reserve University
CoE	Center of Excellence	CY	Calendar year
COF	Covalent-organic framework	CZO	Ceria-zirconia
COF ₂	Carbonyl fluoride	d	Day(s)
CONCAWE	Conservation of Clean Air and Water in Europe	D ₂	Deuterium
COPV	Composite Overwrapped Pressure Vessel		

DA	Dubinin-Astakhov	DP	Dew point
DAC	Donor-acceptor-complex	DPD	Dissipative particle dynamics
DADB	Diammoniate of diborane, [(NH ₃) ₂ BH ₂][BH ₄]	DRIFTS	Diffuse reflectance infrared Fourier transform spectroscopy
DAS	Data acquisition system	DSC	Differential scanning calorimetry
dB(A)	Decibel(s) A scale	DSM	Dimensionally stable membrane
DBPDSA	1, 4-dibromo phenylene 2, 5-disulfonic acid	DST	Dynamic stress test
DC	Direct current	DTA	Differential thermal analysis
d_{DR}	Dubini-Radushkevich average micropore diameter	DTI	Directed Technologies, Inc.
DDR	A zeolite structure code	DVBPC	Divinyl aryl ether monomer
DEDP	Distance Education Degree Program	DVD	Digital video disk
DEF	Diethylformamide	DVT	Design verification test
Deg, deg	Degree	e ⁻	Electron
DEGDBE	Diethylene glycol dibutyl ether	E, Ea	Activation energy, kJ/mol
ΔB_a	The difference in magnetic induction at high and low applied magnetic fields	E_0xE_1	Utilization efficiency of incident solar light energy
DEP	Department of Environmental Protection	E_{ad}	Hydrogen adsorption heat
DF	Digital fabrications	E-BOP	Electrical balance of plant
DFM	Design for manufacturing; degree of fuel mixing	EBS	Electron backscatter diffraction
DFMA [®]	Design for Manufacturing and Assembly	EC	Evaporative-cooled, efficiency of conversion
DFT	Density functional theory	ECA	Electrochemical area
DHBC	2,5-dihydroxybenzene dicarboxylate	ECE-WP29/ GRPE	United Nations Economic Commission for Europe, World Forum for Harmonization of Vehicle Regulations, and Working Party on Pollution and Energy Program
DI	Deionized; de-ionized water	ECS	Equilibrium crystal shape
DIG	Digoxigenin	ECSA	Electrochemically active surface area; Electrochemical surface area
DLC	Diamondlike carbon	ECST	College of Engineering, Computer Science and Technology
dL/g	Deciliters per gram	EDA	Ethylene diamine
DMAc	Dimethyl acetamide	EDAX	Manufacturer of energy dispersive X-ray hardware and software
DMDS	Dimethyldisulfide	EDBB	Ethylenediamine bisborane
DME	Dimethyl ether; dimethoxyethane	edmimCl	2-ethyl-1,3-dimethyl-imidazolium ethylsulfate
DMEA	Dimethylethylamine	EDS	Energy dispersive X-ray spectroscopy, energy dispersive spectrum
DMF	n, n-di-methyl formamide	EDTA	Ethylenediamine tetraacetic acid
DMFC	Direct methanol fuel cell	EDX	Energy dispersive X-ray
dmimMeSO ₄	1,3-dimethyl-imidazolium methylsulfate	EE	Electrical engineering
dmpe	Dimethylphosphinoethane	EELS	Electron energy loss spectroscopy
DMPO	5,5-Dimethylpyrroline-N-oxide	EERE	U.S. DOE Office of Energy Efficiency and Renewable Energy
DMSO	Dimethyl sulfoxide	EFR-AHJ	Emergency first responder-authorities having jurisdiction
DMT	Dimethyltrityl	e.g.	exempli gratia, for example
DMTHF	Dimethyltetrahydrofuran		
DNA	Deoxyribonucleic acid		
DOD	U.S. Department of Defense		
DOE	U.S. Department of Energy		
DOT	Department of Transportation		
DOT/NHTSA	Department of Transportation/National Highway Traffic Safety Administration		

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EH&S	Environmental Health and Safety	FCFP	FreedomCAR and Fuel Partnership
EHC	Electrochemical hydrogen compressor	FCPP	Fuel cell power plant
EIA	Energy Information Administration of the U.S. Department of Energy	FCS	Fuel cell system
EIHP	European Integrated Hydrogen Project	FC ^{TES} ^{QA}	Fuel Cell Testing, Safety and Quality Assurance (an international effort to harmonize fuel cell testing procedures)
EIS	Electrochemical impedance spectroscopy	FC ^{TEST} ^{NET}	Fuel Cell Testing and Standardization Network
El	Elongation to fracture	FCV	Fuel cell vehicle
eNMR	Electrochemical nuclear magnetic resonance	Fd	Ferredoxin
EOL	End of life	FDA	Finite difference analysis
EPA	U.S. Environmental Protection Agency	FDS	Filter difference spectrometer
EPDM	Ethylene propylene diene monomer	Fe	Iron
ES	Energy storage	FE	U.S. DOE Office of Fossil Energy
ESEM	Environmental scanning electron microscopy	Fe ₂ O ₃	Ferric oxide
ESI-MS	Electrospray ionization mass spectrometry	FEA	Finite element analysis
ESR	Electron spin resonance	FEP	Fluorinated ethylene propylene; Teflon [®]
ESU	Electrostatic unit of charge	FF	Fill factor
et al.	et alii, and others	FFOV	Fossil-fuel onroad vehicle
ET	Event tree	FHWA	Federal Highway Administration
ETA	Event tree analysis	FIB	Focused ion beam
etc.	et cetera, and so on	FLACS	FLame ACceleration Simulator
ETFE	Ethylene-tetrafluoroethylene	FLiNaK	LiF-NaF-KF eutectic salt
EtOH	Ethanol	FMEA	Failure modes and effects analysis
ETR	Electron transfer rate	¹⁹ FNMR	¹⁹ Fluorine nuclear magnetic resonance
EU	European Union	FOM	Federated object model; figure of merit
eV	Electron volt	FP	Fuel processor
EVS	Electric Vehicle Symposium and Exhibition	FPA	Fluoroalkyl phosphonic and phosphinic acids
EW	Enthalpy wheel; equivalent weight	fpi	Fins per inch
EWH	Enthalpy wheel humidifier	fpm	Feet per minute
EXAFS	Extended X-ray absorption fine structure analysis	FMVSS	Federal Motor Vehicle Safety Standards
F	Fluorine; Faraday constant, the amount of electric charge in one mole of electrons (96,485.3383 coulomb/mole)	FRP	Fiber-reinforced polymer
F	Fluorine ion	FRR	Fluoride release rate
FA	Furfyl alcohol	FSEC	Florida Solar Energy Center
FAT	Fleet Analysis Toolkit	F-SPEEK	Fluorosulfonic acid of polyetheretherketone
FBMR	Fluidized bed membrane reactor	ft	Feet
FC	Fuel cell	FT	Fault tree
FCB	Fuel cell bus	ft ²	Square feet
fcc	Face-centered cubic	ft ³	Cubic feet
FCCP	Carbonyl cyanide m-chlorophenylhydrazone	FTA	Federal Transit Administration; fault tree analysis
FCE	FuelCell Energy	FT-IR, FTIR	Fourier transform infrared
FCEV	Fuel cell electric vehicle	FTIR-ATR	Fourier transform infrared attenuated total reflection
		FTO	Fluorine-doped tin oxide
		FTP	Federal Test Procedure

FW	Filament winding	GNF	Graphite nanofiber
FWHM	Full width at half maximum	GOS	Global ocean sampling
FY	Fiscal year	GPa	Gigapascal(s)
ΔG	Gibbs free energy of reaction	GPC	Gel permeation chromatography
g	Gram; acceleration of gravity	GPS	Global positioning system
G	Graphite	GRC	Glass-reinforced concrete
Ga	Gallium	GREET	Greenhouse gases, Regulated Emissions and Energy use in Transportation model
GA	General Atomics		
GaAs	Gallium arsenic	g/s	Grams per second
gal	Gallon	GTI	Gas Technology Institute
GaP	Gallium phosphide	GTR	Global Technical Regulations
GATOR- GCMOM	Gas, Aerosol, Transport, Radiation, General Circulation, Mesoscale, and Ocean Model	GUI	Graphical user interface
GB	Gigabyte	GV	Gasoline vehicle
GC	Gas chromatograph	GW	Product of the Green's function, G, and the energy, W; an approximation permitting practical calculation of excitation energies in metals, semi- conductors and insulators
g/cc	Grams per cubic centimeter	GWe	Gigawatt(s) electric
GCLP	Grand-canonical linear programming	ΔH	Enthalpy of reaction, Enthalpy of hydrogenation
GCMC	Grand Canonical Monte Carlo	ΔH_f°	Standard heat of formation
GCMS	Gas chromatograph mass spectroscopy	h, hr, hrs	Hour(s)
Gd	Gadolinium	H	Hydrogen
GDC	Gadolinium-doped ceria	H ⁺	Proton
GDE	Gas diffusion electrode	H ⁻	Hydride
GDL	Gas diffusion layer	H ₂	Diatomic hydrogen
GDM	Gas diffusion media	H2A	Hydrogen Analysis project sponsored by DOE
GDS	Galvanodynamic scan		
Ge	Germanium	H ₂ BPyDC	2,2'-bipyridine-5,5'-dicarboxylic acid
Gen I	First generation	H ₂ cat	Catechol; 1,2 dihydroxybenzene
GES	Giner Electrochemical Systems, LLC	H ₂ -FCS	Stationary fuel cell system designs that co-produce hydrogen
GGA	Generalized gradient approximation		
GGE, gge	Gasoline gallon equivalent	H ₂ (hfipbb)	4,4'-(hexafluoroisopropylidene) bis(benzoic acid)
GH ₂	Gaseous hydrogen	H ₂ ICE, H2-ICE	Hydrogen internal combustion engine
GHG	Greenhouse gas	H ₂ O	Water
GHSV	Gas hourly space velocity	H ₂ O ₂	Hydrogen peroxide
GIC	Graphite intercalation complex	H ₂ oba	4,4'-oxybis-benzoic acid
GIS	Geographic information system	H2QWG	DOE Hydrogen Quality Working Group
GJ	Gigajoule(s)	H ₂ S	Hydrogen sulfide
g/kW	Gram(s) per kilowatt	H ₂ SO ₄	Sulfuric acid
GLACD	Glancing angle co-deposition	H ₃ BBC	1,3,5-tris(4'-carboxy[1,1'-biphenyl]-4-yl)- benzene
GLAD	Glancing angle deposition		
GLY	Glycerol	H ₃ BTB	4,4',4''-benzene-1,3,5-triyl-tribenzoic acid
Glyme	Dimethoxyethane	H ₃ PO ₄	Phosphoric acid
gm	Gram(s)	HAADF	High-angle annular dark-field
GM	General Motors	HAADF-STEM	High angle annular dark field scanning transmission electron microscopy
gm/day	Gram(s) per day		
g/min	Gram(s) per minute		

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HAMMER	Hazardous Materials Management and Emergency Response	HKUST	1 Cu ₃ (1,3,5-benzenetricarboxylate) ₂
HATCI	Hyundai-KIA America Technical Center Inc.	HLA	High level architecture
HAVO	Hawaii Volcanoes National Park	HMC	Hyundai Motor Company
HAZ	Heat affected zone	HNEI	Hawaii Natural Energy Institute
HAZID	Hazard Identification Analysis	HNO ₃	Nitric acid
HAZOP	Hazards and Operational Safety Analysis, hazards and operability analysis	HOMO	Highest occupied molecular orbital
H-Bcat	Catecholborane where boron is bound to catecholate dianion and a hydride (B-H)	hp	Horsepower
HBr	Hydrogen bromide	HP	High-pressure
HBTU	o-Benzotriazol-1-yl-N,N,N',N'-tetramethyluronium hexafluorophosphate	HPA	Heteropoly acid
HCl, HCL	Hydrochloric acid; hydrogen chloride	HPLC	High performance liquid chromatography
HClO ₄	Perchloric acid	HPRD	Hydrogen pressure relief device
HCO ₃ ⁻	Bicarbonate	hr	Hour(s)
hcp	Hexagonal close-packed	HRL	Hughes Research Laboratory, HRL Laboratories, LLC
HD	Deuterium hydride	HRL meso-C	Mesoporous carbon synthesized by HRL using pyrolysis of mesoporous polymer
HDPE	High-density polyethylene	HRTEM	High-resolution transmission electron microscopy
HDSAM	Hydrogen Delivery Scenario Analysis Model	HRXRT	High-resolution X-ray tomography
He	Helium	HSC	Database name derived from the letters for enthalpy, entropy and heat capacity
HE	Hydrogen embrittlement	HSCoE	Hydrogen Sorption Center of Excellence
HEHP	High-energy, high-pressure	HSDC	Hydrogen Secure Data Center
HES	Hydrogen energy station	HSECoE	Hydrogen Storage Engineering Center of Excellence
HEV	Hybrid electric vehicle	HSO ₄	Bisulfate anion
HEX	Heat exchange	HSRP	Hydrogen Safety Review Panel
Hf	Hafnium	HSU	Humboldt State University; hydrogen separation unit
HF	Hydrofluorhydric acid; hydrogen fluoride; Hartree Fock	HT	High-temperature
HFB	Hexafluorobenzene	HTE	High-temperature electrolysis
HFCIT	Hydrogen, Fuel Cells and Infrastructure Technologies Program	HTF	Heat transfer fluid, Hydrogen test facility
HFCT	Hydrogen and fuel cell technology	HTGR	High-temperature gas-cooled reactor
HFCV	Hydrogen fuel cell vehicle	HTHX	High-temperature heat exchanger
HFP	Hexafluoropropylene; 1,1,1,3,3,3 hexafluoro-2-propanol	HTM	High-temperature membrane; hydrogen transport membrane
HFR	High-frequency impedance; high-frequency resistance	HTMWG	High Temperature Membrane Working Group
HFS	Hydrogen fueling station	HTP	High throughput
HGMs	Hollow glass microspheres	HTSC	High temperature superconductor
HHV	Higher heating value	HTSE	High temperature steam electrolysis
HI	Hydrogen iodide; hydriodic acid	HT-WGS	High-temperature water-gas shift
HIC	Hydrogen-induced cracking	HTXRD	High-temperature X-ray diffraction
HiCON	High CO Conversion Process	H _{upd}	Hydrogen underpotential deposition
HIPOC	Hydrogen Industry Panel on Codes	HWCVD	Hot-wire chemical vapor deposition
HIx	Blend of hydrogen iodide, iodine, and water	HWFET	Highway Fuel Economy Test
		HX	Heat exchanger

HyDRA	Hydrogen Demand and Resource Analysis	INS	Inelastic neutron scattering
HyDS-ME	Hydrogen Deployment System Modeling Environment	IPA	Isophthalate
HYPHER	HYdrogen PERmitting	IPCC	Intergovernmental Panel on Climate Change
HyS	Hybrid sulfur	IPCC SRES	IPCC Special Report on Emissions Scenarios
HYSYS®	Process simulation software by AspenTech, computer code for flowsheet analysis	IPCE	Incident photon conversion to electrons, incident photon conversion efficiency
Hz	Hertz	IPES	Inverse photoemission spectroscopy
i	Current density (mA/cm ²)	IPG	Installation Permitting Guidance
I	Current	IPHE	International Partnership for the Hydrogen Economy
I ₂	Diatomic iodine	IPPSS	Integrated Power Plant/Storage System
IC	Internal combustion	IPTG	Isopropyl β-D-1-thiogalactopyranoside
ICC	International Code Council	iR	Internal resistance; voltage loss due to resistance
ICE	Internal combustion engine	Ir	Iridium
ICEV	Internal combustion engine vehicle	IR	Infrared
ICP	Inductively coupled plasma	IRDA	Infrared data acquisition
ICPAE	Inductively coupled plasma atomic emission	IRMOF	Isoreticular metal organic framework
ICP-AES	Inductively coupled plasma atomic emission spectroscopy	ISIS	Pulsed neutron and muon source located at the UK Rutherford Appleton Laboratory
ICP-MS	Inductively coupled plasma mass spectrometry	ISO	International Organization for Standardization
ICP-OES	Inductively coupled plasma optical emission spectroscopy	ITM	Ion transport membrane
ICR	Interfacial contact resistance	ITO	Indium tin oxide
ICSD	Inorganic Crystal Structure Database	ITP	Indium tin phosphate
ID	Inside diameter	ITS	Institute of Transportation Studies
i.e.	id est, that is	IV	Current-voltage
IE	Initiating event	J	Current; Joule(s)
IEA	International Energy Agency	JARI	Japan Automobile Research Institute
IEA-HIA	International Energy Agency Hydrogen Implementing Agreement	JFK	John F. Kennedy (airport)
IEC	International Electrotechnical Commission; ion exchange capacity	JHQTF	Joint Hydrogen Quality Task Force (U.S. Fuel Cell Council)
IFC	International Fire Code	JMFC	Johnson Matthey Fuel Cells, Inc.
IGT	Institute of Gas Technology	JP-8	Jet fuel (Propellant 8)
IHPV	Internally heated high-pressure vessel	JPL	Jet Propulsion Laboratory
IINS	Inelastic incoherent neutron scattering	Jsc	Short circuit current density
IIT	Illinois Institute of Technology	JV	Current density-voltage
IL	Ionic liquid	K	Sievert's constant, ml/(cm ² -min-atm ^{1/2}); Kelvin, absolute temperature; Potassium
ILS	Integrated laboratory scale	kÅ	1,000 angstroms
In	Indium	kA/m ²	Kilo-ampere(s) per square meter
In., in	Inch	KBr	Potassium bromide
in ²	Square inch	kcal	Kilocalorie(s)
INERI	International Nuclear Energy Research Initiative	kcal/mol	Kilocalorie(s) per mole
INL	Idaho National Laboratory	KeV	Kilo electron volt(s)

XII. Acronyms, Abbreviations and Definitions

kg	Kilogram(s)	LDA	Local density approximation
kg/d	Kilogram(s) per day	LDV	Light-duty vehicle
kg/hr	Kilogram(s) per hour	LED	Light emitting diode
kg/m ³	Kilogram(s) per cubic meter	LEL	Lower explosion limit
KH	Potassium hydride	LFG	Land fill gas
KHTC	Potassium-promoted hydrotalcite	LFL	Lower flammability limit
kHz	Kilohertz	L/h, l/h	Liter(s) per hour
KIA	Kia Motor Company	LH ₂ , LH ₂	Liquid hydrogen
K _{IC}	Fracture toughness	LHC	Light-harvesting chlorophyll
K _{IH}	Fracture toughness measured in hydrogen gas	LHS	Lawrence Hall of Science
kJ	Kilojoule(s)	LHSV	Liquid hourly space velocity
kJ/mol	Kilojoule(s) per mole	LHV	Lower heating value
km	Kilometer(s)	Li	Lithium
KMC	Kia Motors Corporation	Li ₃ N	Lithium nitride
KOH	Potassium hydroxide	Li-AB	Lithium amidoborane; Li-NH ₂ -BH ₃
kPa	Kilopascal(s)	LiBH ₄	Lithium borohydride
kph	Kilometer(s) per hour	LIBS	Laser-induced breakdown spectroscopy
K _{TH}	Hydrogen-assisted crack growth threshold	LiH	Lithium hydride
Kth	Fracture toughness threshold	LIM	Liquid injection molding; liquid injection moldable
kW	Kilowatt(s)	LLC	Limited Liability Company
kW _e	Kilowatt(s) electric	LLNL	Lawrence Livermore National Laboratory
kWh	Kilowatt-hour(s)	LMDS	Laser modulation differential spectroscopy
kWh/kg	Kilowatt-hour(s) per kilogram	L/min, l/min	Liter(s) per minute
kWh/L	Kilowatt-hour(s) per liter	LMWO	Lanthanum molybdenum tungsten oxide (e.g., La ₂ Mo _{1.8} W _{0.2} O _{9-x})
kW/kg	Kilowatt(s) per kilogram	LN ₂	Liquid nitrogen
kWt	Kilowatt(s) thermal	LNG	Liquefied natural gas
λ	Lambda, hydration number	LOHC	Liquid organic hydrogen carrier
L, l	Liter(s)	LPG	Liquefied petroleum gas
La	Lanthanum	LPM	Liter(s) per minute
LAMOX	Lanthanum molybdenum oxide (e.g., La ₂ Mo ₂ O ₉)	LQ*	Dehydrogenated liquid carrier
LANL	Los Alamos National Laboratory	LQ*H ₂	Hydrogenated liquid carrier
LAO	Lanthanum-modified alumina	LSC	Lanthanum strontium cobalt oxide, (La, Sr)CoO ₃ , strontium-doped lanthanum cobaltite; La _{0.8} Sr _{0.2} CoO _{3+δ}
LAX	Los Angeles International Airport	LSCF	Lanthanum strontium cobalt iron oxide, (La, Sr)(Co, Fe)O ₃
lb	Pound(s)	LSCF7328	La-Sr-Cu-Fe-O
LBM	Lattice Boltzmann method	LSCM	Lanthanum strontium chromium manganese oxide, (La, Sr)(Cr, Mn)O ₃
lbmol	Pound-mole(s)	LSCr	Lanthanum strontium chromium oxide, (La, Sr)CrO ₃
LBNL	Lawrence Berkeley National Laboratory	LSDA	Local spin density approximation
LC	Liquid carrier	LSM	Lanthanum strontium manganese oxide, (La, Sr)MnO ₃ , strontium-doped lanthanum manganite, La _{0.8} Sr _{0.2} MnO _{3+δ}
LCA	Life cycle assessment		
LCC	La _{0.7} Ca _{0.3} CrO _{3-δ}		
LCH ₂	Hydrogenated liquid carrier; liquid to compressed hydrogen		
LC-MS	Liquid chromatography-mass spectroscopy		
L/D	Length to diameter ratio		

LST	Lanthanum strontium titanium oxide, (La, Sr)TiO ₃	MeAB	Methylamine borane
LSV	Lanthanum strontium vanadate; linear sweep voltammetry	MEAM	Modified embedded atom method
LT	Low-temperature	MEC	Microbial electrolysis cell, Minimum explosive concentration
LTDMS	Laser induced thermal desorption mass spectrometry	MECS	Microtechnology-based energy and chemical systems
LUMO	Lowest unoccupied molecular orbital	MEMS	Micro-electro-mechanical systems
LV	Louver fins	MeOH	Methanol
m	Meter(s)	MEOP	Maximum expected operating pressure
M	Mole; molar; million	meq	Milliequivalents
m ²	Square meter(s)	meq/g	Milliequivalents/gram
m ² /g	Square meter(s) per gram	MeV	Mega electron volt
m ² /s	Square meter(s) per second	MFC	Microbial fuel cell, Mass flow controller
m ³	Cubic meter(s)	MFE	Membrane-free extract
M41	Arkema's second-generation membrane candidate	MFI	A zeolite structure code
M43	Arkema's third-generation membrane candidate	Mg	Megagram(s)
M70	Arkema's fourth-generation membrane candidate	μg	Microgram(s)
mΩ	Milli-ohm(s)	mg	Milligram(s)
MΩ	Mega-ohm(s)	MgCl ₂	Magnesium chloride
mΩ/cm ²	Milli-ohm(s) per square centimeter	mg/cm ²	Milligram(s) per square centimeter
mA	Milliamps (s)	MgH ₂	Magnesium hydride
μA	Micro-ampere(s)	MgH ₂ @C	MgH ₂ incorporated in carbon scaffold
M-AB	Metal ammonia-borane	MgO	Magnesium oxide
mA/cm ²	Milliamp(s) per square centimeter	Mg(OH) ₂	Magnesium hydroxide
μA/cm ²	Micro-ampere(s) per square centimeter	mgPt/cm ²	Milligram (s) of platinum per square centimeter
MALDI	Matrix-assisted laser desorption/ionization	MH	Membrane humidifier; metal hydride
MAS	Magic angle spinning	MHC	Metal hydride-based compressor
MAS ¹¹ B-NMR	Magic angle spinning boron-11 nuclear magnetic resonance spectroscopy	MHCoE	Metal Hydride Center of Excellence
MAS-NMR	Magic angle spinning nuclear magnetic resonance	MHz	Megahertz
MB	Megabyte	mi	Mile(s)
MBE	Molecular beam epitaxy	MI	Mixed inocula
MBMS	Molecular beam mass spectrometry	MIE	Minimum ignition energy
MBWR	Modified Benedict Webb Rubin	MIEC	Mixed ionic and electronic conduction
MC	Monte Carlo; microchannel	mi/kg	Mile(s) per kilogram
mC ²	Multi-component composite (membrane)	mil	Millimeter(s)
mC-cm ⁻²	MilliCoulomb(s) per square centimeter	min	Minute(s)
MCFC	Molten carbonate fuel cell	MIT	Massachusetts Institute of Technology
MD	Molecular dynamics	MiT ⁱ	Mohawk Innovative Technologies Inc.
MDES	Methyl-diethoxy silane	MJ	Megajoule(s)
mdip	5,5'-methylene-di-isophthalate	mL, ml	Milliliter(s)
MEA	Membrane electrode assembly	ML	Monolayer
		μm	Micrometer(s); micron(s)
		μM	Micromolar
		mm	Millimeter(s)
		mM	Millimolar
		MMBtu	Million British thermal units

XII. Acronyms, Abbreviations and Definitions

MMOF	Metal-organic framework	mW	Milliwatt(s)
mmol	Millimole(s)	MW	Megawatt(s); molecular weight
μmol	Micromole(s)	mW/cm ²	Milliwatt(s) per square centimeter
MMSCFD	Million standard cubic feet/day	MWCNT	Multiple-wall carbon nanotube
Mn	Manganese	MWe	Megawatt(s) electric
Mn ₂ O ₃	Manganese oxide	MWh	Megawatt-hour(s)
M-N-H	Amide/imide	MWNT	Multi-wall carbon nanotube
MnO	Manganese oxide	MWOE	Midwest Optoelectronics, LLC
Mo	Molybdenum	MWth	Megawatt(s) thermal
MO	Molecular orbital; metal oxide	MYPP	Multi-Year Program Plan (the HFCIT Program's Multi-Year Research, Development and Demonstration Plan), Multi-year product plan
MOF	Metal-organic framework		
mol	Mole(s)		
mol%	Mole percent	N	Normal (e.g., 1N H ₃ PO ₄ is 1 normal solution of phosphoric acid); Nitrogen atom; Newton (unit of force)
mol/min	Mole(s) per minute		
mΩ	Milli-ohm(s)		
MΩ	Mega-ohm(s)	N112	Nafion [®] 1100 equivalent weight, 2 millimeter thick membrane
mΩ/cm ²	Milli-ohm(s) per square centimeter		
μΩ-cm ²	Micro-ohm(s) - square centimeter	N ₂	Diatomic nitrogen
MoPc	Molybdenum phthalocyanine	N ₂ O	Nitrous oxide
MOZART	Model for OZone And Related Trace species chemical-transport model of the global atmosphere	Na	Sodium
		Na ₂ S	Sodium sulfide
		Na ₃ AlH ₆	Trisodium hexahydroaluminate
MP2	Second-order Moller-Plesset perturbation theory	NaAlH ₄	Sodium aluminum hydride; sodium tetrahydroaluminate; sodium alanate
MPa	Megapascal (s)	NaBH ₄	Sodium borohydride
MPG, mpg	Mile(s) per gallon	NaBO ₂	Sodium metaborate
mph	Mile(s) per hour	NaCl	Sodium chloride
MPL	Microporous layer	NADH	(reduced) Nicotinamide adenine dinucleotide
MPMC	Massively Parallel Monte Carlo		
MPPO	Modified poly(phenylene oxide)	Nafion [®]	Registered Trademark of E.I. DuPont de Nemours
MPPT	Maximum power point tracker		
MRI	Magnetic resonance imaging	NaH	Sodium hydride
ms	Millisecond(s)	NaOH	Sodium hydroxide
MS	Mass spectroscopy, mass spectrometry	NAS	National Academy of Sciences
M-S	Mott-Schottky	NASA	National Aeronautics and Space Administration
MSA	Metropolitan statistical area; methanesulfonic acid		
		NASFM	National Association of State Fire Marshals
mS/cm	Milli-Siemen(s) per centimeter		
MS-EVB	Multi-state empirical valence bond method for simulating proton transport via the Grotthuss shuttling mechanism	Nb	Niobium
		N/cm ²	Newton(s) per square centimeter
		NCN	Nano capillary network
MSM	Macro-System Model	NCNR	NIST Center for Neutron Research
MSR	Membrane steam reformer	nc-Si:H	Nanocrystalline silicon
MTA	Metric tonne per annum	NCSR	National Center of Scientific Research
mtorr	Millitorr	ND	Not determined at this time
μV	Micro volt(s)	NDC	New delivery concept
mV	Millivolt(s)	NDE	Non-destructive examination
MV	Methyl viologen		

NE	U.S. DOE Office of Nuclear Energy, Science and Technology	NPM	Nanostructured polymeric materials; non-precious metal
NEC	National Electrical Code	NPPD	n-phenyl-phenylenediamine
NEDO	New Energy and Industrial Technology Development Organization (Japan)	NPT	Normal pressure and temperature
NEED	National Energy Education Development Project	NPV	Net present value
NEPA	National Environmental Policy Act	NR ₃	Tertiary amine
NERI	Nuclear Energy Research Initiative	NRC	National Research Council
NERI-C	Nuclear Energy Research Initiative-Consortium	NREL	National Renewable Energy Laboratory
NESSHY	Novel Efficient Solid Storage of Hydrogen	NSF	National Science Foundation
NETL	National Energy Technology Laboratory	NSTF	Nano-structured thin-film
NFC	Near-frictionless carbon	NSTFC	Nano-structured thin film catalyst
NFM	Nanoporous framework material	NTE	Negative thermal-expansion
NFPA	National Fire Protection Association	NV	Neutron vibrational
ng	Nanogram	NVS	Neutron vibrational spectroscopy
NG	Natural gas	O	Oxygen
NGNP	Next Generation Nuclear Plant	O ₂	Diatomic oxygen
NG-SR	Natural gas steam reforming	O/C	Oxygen-to-carbon ratio
NGV	Natural gas vehicle	OCP	Open circuit potential
NH ₃	Ammonia	OCSD	Orange County Sanitation District
NHA	National Hydrogen Association	OCV	Open-circuit voltage
NHE	Normal hydrogen electrode	o.d., OD	Outer diameter
NHI	Nuclear Hydrogen Initiative	ODA	Oxygenated form of diamine
NHTSA	National Highway Traffic Safety Administration of the U.S. Department of Transportation	OEC	Oxygen evolving complex
Ni	Nickel	OEM	Original equipment manufacturer
NILS	Normal interstitial lattice sites	OER	Oxygen evolution reaction
NiMH	Nickel metal hydride	OH [•]	Hydroxyl radical
NIST	National Institute of Standards and Technology	OHFCIT	Office of Hydrogen, Fuel Cells, and Infrastructure Technologies
NL	Normal liter(s)	Ω	Ohm(s)
nm	Nanometer(s)	Ω-cm ²	Ohm-square centimeter
NM	Noble metal	O&M	Operation and maintenance
Nm ³	Normal cubic meter(s)	OMC	Ordered mesoporous carbon
nmol	Nanomole(s)	ORNL	Oak Ridge National Laboratory
NMP	N-methylpyrrolidone	ORNL-HTML	Oak Ridge National Laboratory High Temperature Materials Laboratory
NMR	Nuclear magnetic resonance	ORR	Oxygen reduction reaction
NO ₂	Nitric oxide	OSC	Oxygen storage capability; Orlando Science Center
NOA	Norland Optical Adhesive	OSHA	U.S. Occupational Safety and Health Administration
NO _x	Oxides of nitrogen	OSM	Oregon Steel Mills, Optical scatterfield microscopy
NPB	Neopentyl benzene	OSU	Ohio State University; Oregon State University
NPC	Nanoporous carbon	o-SWNH	Oxidized single-walled nanohorn
NPD	Neutron powder diffraction	OTM	Oxygen transport membrane
NPDF	Neutron powder diffraction	ΔP	Pressure drop, pressure change
		P	Phosphorus; pressure

XII. Acronyms, Abbreviations and Definitions

$p\text{-H}_2$	Para-hydrogen	PEI	Polyetherimide
Pa	Pascal(s)	PEKK	Poly (ether ketone ketone)
PA	Phenylacetylene; polyamide	PEM	Polymer electrolyte membrane; proton exchange membrane
PAA	Poly(acrylic acid)	PEMFC	Polymer electrolyte membrane fuel cell; proton exchange membrane fuel cell
PAFC	Phosphoric acid fuel cell	PEN	Polyethylene naphthalate
PAN	Peroxyacetyl nitrate	PEO	Poly(ethylene oxide)
PANI	Polyaniline	PES	Polyether sulfone; polyethersulfone-polyimide copolymer
PA/PBI	Phosphoric-acid-doped polybenzimidazole	PET	Polyethylene terephthalate
PAR	Photosynthetically-active radiation	PF	Phenolic
PAS	Photoactive semiconductor	PFA	Perfluoroalkoxy (a type of fluoropolymer); polyfurfuryl alcohol
PAW	Projector augmented wave	PFAC	PFA-derived carbon
Pb	Lead	PFCS	Poly-generative fuel cell systems
PB	Polyborazylene	PFD	Process flow diagram
PbA	Lead acid	PFM-NMR	Pulse field gradient nuclear magnetic resonance
PBE	Perdew-Burke-Ernzerhof	PFGE	Pulse field gradient spin echo
PBI	Polybenzimidazole	PFSA	Perfluorinated sulfonic acid; perfluorosulfonic acid
PbO	Lead oxide	PG	Propylene glycol
PBPDSA	poly(biphenylene disulfonic acid)	PGAA	Prompt gamma activation analysis
P-C	Pressure-composition	PGE	Platinum group element
PC	Polycarbonate	PGM	Precious group metal; platinum group metal
PCE	Perchloroethylene	PGSE	Pulsed-field gradient spin-echo
PCF	Polycarbonate film	$p\text{-H}_2$	Para-hydrogen
PCHD	Poly(cyclohexadiene)	Ph_3SnCl	Triphenyltin chloride
PCI	Pressure-composition isotherm	$\text{Ph}_3\text{SnSnPh}_3$	Hexaphenyldistannane
PCM	Power control module	PHEV	Plug-in hybrid vehicle
P-C-P	Phosphorus-carbon-phosphorus	PhOH	Phenol
PCR	Polymerase chain reaction	PI	Principal investigator; polyimide
PCT, P-C-T	Pressure-concentration-temperature	P&ID	Piping and instrumentation diagram; process and instrumentation diagram
Pd	Palladium	PIL, pIL	Protic ionic liquid
PD	Power density	PIM, pIM	Protic ionic membrane
PdAg	Palladium-silver alloy	PLC	Programmable logic controller
PdCu, Pd-Cu	Palladium-copper alloy	PLLA	Poly-L-lactic acid
PdCuTM	Palladium copper transition metal	PM	Precious metal such as platinum
PDF	Probability density function; pair distribution function	PM_{10}	Particulate matter with diameters of 10 micrometers or less
PDU	Process development unit	$\text{PM}_{2.5}$	Particulate matter with diameters of 2.5 micrometers or less
PE	Polyethylene, proton conductor	PNNL	Pacific Northwest National Laboratory
PEC	Photoelectrochemical; photoelectrochemical cell	$p\text{O}_2$	Oxygen partial pressure
PECVD	Plasma-enhanced chemical vapor deposition	POC	Proof of concept
PEEK	Polyether ether ether ketone		
PEFC	Polymer electrolyte fuel cell		
PEG	Polyethylene glycol		
PEGS	Prototype electrostatic ground state		

POCOP	<i>P,P</i> -bis(1,1-dimethylethyl)-,3-[[<i>bis</i> (1,1-dimethylethyl)phosphino]oxy]phenyl ester	PTA	Phosphotungstic acid
POF	Polymeric-organic frameworks	Pt/AC/BC/IRMOF-8	Isorecticular metal organic framework (MOF) doped with platinum supported on activated carbon, and further coupled to MOF with a bridging compound
POM	Polyoxometallate	Pt/AX-21	Pt-doped microporous carbon AX-21
POSS	Polyhedral oligomeric silsesquioxane	Pt/C	Platinum/carbon
POX	Partial oxidation	PTFE	Teflon [®] – poly-tetrafluoroethylene
PP	Polyphosphazene, polypropylene	Pt-FePO	Platinum iron phosphate
PPA	polyphosphoric acid	Pt-MM	Platinum group mixed metal
ppb	Part(s) per billion	Pt-NH	Platinum decorated carbon nano-horns
ppbv	Part(s) per billion by volume	PtO	Platinum oxide
PPDSA	Poly (p-phenylene disulfonic acid)	PtO ₂	Platinum dioxide
PPI	Pore(s) per inch	PtRu	Platinum ruthenium
ppm, PPM	Part(s) per million	Pt-SWNH	Platinum decorated single-walled nanohorns
ppmv	Part(s) per million by volume	Pt-TaPO	Platinum tantalum phosphate
ppmw	Part(s) per million by weight	PTW	Pump-to-wheels
PPO	Phenyl phosphine oxide	PV	Photovoltaic
PPS	Polyphenylenesulfide	PVA	Polyvinyl
PPSA	Poly (p-phenylene sulfonic acid); partial pressure swing adsorption	PVC	Polyvinyl chloride
PPSU	Polyphenylsulfone	PVD	Physical vapor deposition
PPy	polypyrrole	PVDF	Polyvinylidene fluoride
Pr	Praseodymium	PVP	Polyvinylpyrrolidone
PRD	Pressure relief device	PVPP	Polyvinyl pyridinium phosphate
PrOx	Preferential oxidation	PVT, P-V-T	Pressure-Volume-Temperature
PRSV	Peng-Robinson Stryjek-Vera	PyC	4-pyrazole carboxylate
PS	Proton sponge (bis- (dimethylamino) naphthalene); polysiloxane	PzDC	2,8-pyrazabole dicarboxylate
PSA	Pressure swing adsorption, adsorber	Q	Neutron momentum transfer
PSAT	Powertrain Systems Analysis Toolkit, a vehicle simulation software package developed at Argonne National Laboratory	Q1, Q2, Q3, Q4	Quarters of the fiscal year
PSD	Particle size distribution, pore size distribution	QC	Quality control; quantum corrections
PSEPVE	Perfluoro (4-methyl-3,6-dioxaoct-7-ene) sulfonyl fluoride	QCM	Quartz crystal microbalance
psi, PSI	Pound(s) per square inch	QENS	Quasielastic neutron scattering
psia	Pound(s) per square inch absolute	Q-HOP MD	A version of a molecular dynamics simulation that includes quantum chemistry calculations
psid	Pound(s) per square inch differential	QLRA	Qualitative risk analysis
psig, PSIG	Pound(s) per square inch gauge	QMC	Quantum Monte Carlo
PSU	Pennsylvania State University	QRA	Quantitative risk assessment
Pt	Platinum	Qst	Isosteric heats of adsorption
PT	Phosphazene trimer	R	Universal or ideal gas constant, 8.314472 J · K ⁻¹ · mol ⁻¹
P-T	Pressure-temperature	RA	Reduction of area
Pt ₃ Co	Platinum-cobalt alloy	Raman	Spectroscopic technique
Pt ₃ Fe	Platinum-iron alloy	R&D	Research and development
Pt ₃ Ni	Platinum-nickel alloy	RD&D, R,D&D	Research, development & demonstration
		RDE	Rotating disk electrode

XII. Acronyms, Abbreviations and Definitions

RDU	Reactor development unit	SDE	SO ₂ -depolarized electrolyzer
REC	Renewable energy credit	SDO	Standards development organization
RF, rf	Radio frequency	Se	Selenium
RGA	Residual gas analyzer (analysis)	SE	Secondary electron
Rh	Rhodium	sec	Second(s)
RH	Relative humidity	SEC	Size exclusion chromatography
RHE	Reference hydrogen electrode; reversible hydrogen electrode	SEM	Scanning electron microscopy, scanning electron microscope
RNA	Ribo nucleic acid	SENT	Single edge notch tension
rpm, RPM	Revolution(s) per minute	SEO	State Energy Office
RPN	Risk priority number	SERC	Schatz Energy Research Center
RPSA	Rapid pressure swing adsorption	SF ₆	Sulfur hexafluoride
RRC	Regional resource center	SFC2	SrFeCo _{0.5} O _x
RRDE	Rotating ring disc electrode	SFT	Sr-Fe-Ti oxide
RSA	Random sequential adsorption	SHE	Standard hydrogen electrode
RT	Room temperature	Si	Silicon
Ru	Ruthenium	Si ₃ N ₄	Silicon nitride
s	Second(s)	S-I	Sulfur-iodine
S	Siemen(s); Sulfur	SI	Sulfur-iodine cycle
SA	Surface area	SiC	Silicon carbide
SAE	Society of Automotive Engineers	SiCN	Silicon carbonitride
SAFC	Solid acid fuel cell	SiO ₂	Silicon dioxide
SAH	Sodium aluminum hydride	sL	Standard liter (0°C, 1 atm)
SANS	Small angle neutron scattering	slpm, slm, sL/min	Standard liter(s) per minute
SAXS	Small angle X-ray scattering	SMEs	Subject matter experts
S _{BET}	BET specific surface area	SMR	Steam methane reformer; steam methane reforming
SBH	Sodium borohydride	SMUD	Sacramento Municipal Utility District
SBIR	Small Business Innovation Research	Sn	Tin
SBU	Secondary building units	SNL	Sandia National Laboratories
Sc	Scandium	SNS	Spallation neutron source
S/C	Steam to carbon ratio	SNTT	Spiral notch torsion test
SCCM, sccm	Standard cubic centimeter(s) per minute	SLAC	Stanford Linear Accelerator Center
SCE	Saturated calomel electrode	SLPH, slph	Standard liter(s) per hour
SCF, scf	Standard cubic feet, supercritical fluid	SLPM, slpm	Standars liter(s) per minute
SCFD, scfd	Standard cubic feet per day	SnO	Tin oxide
SCFH, scfh	Standard cubic feet per hour	SnO ₂	Tin dioxide
SCFM, scfm	Standard cubic feet per minute	SO ₂	Sulfur dioxide
S/cm	Siemen(s) per centimeter	SO ₃	Sulfur trioxide
SCR	Selective catalytic reduction, semi-conductor rectifier	SOC	State-of-charge
ScSZ	Scandia-stabilized zirconia	SOEC	Solid oxide electrolysis cell; solid oxide electrolyzer cell
SD	Standard deviation	SOFC	Solid oxide fuel cell
SDAPP	Sulfonated Diels-Alder polyphenylene	SOFEC	Solid oxide fuel-assisted electrolysis cell
SDAPPe	Sulfonated Diels-Alder polyphenylene ether	SOW	Statement of work
SDC	Samarium doped ceria	SOx	Oxides of sulfur
SDD	Si-drift detector		

sPAES	Sulfonated poly(arylene ether sulfone)	TBAB	Tetra- <i>n</i> -butylammonium bromide
SPEEK	Sulfonated poly(ether ether ketone)	TBABh	Tetra- <i>n</i> -butylammonium borohydride
SPEKK	Sulfonated polyether(ether ketone ketone)	TBA ₂ B ₁₂ H ₁₂	Tetra- <i>n</i> -butylammonium dodecahydrododecaborate
SPEX	Type of milling machine	TBA-PF ₆	Tetra- <i>n</i> -butylammonium hexafluorophosphate
sPOSS	Sulfonated octaphenyl polyhedral oligomeric silsesquioxanes	TBD	To be determined
sq. in.	Square inch(es)	TBMD	Tight-binding molecular dynamic
Sr	Strontium	TC	Thermocouple
SR	Steam reformer; steam reforming	TCCR	Transparent, conducting and corrosion resistant
SR-M	Steam reformer membrane	TCD	Thermal conductivity detector
SRNL	Savannah River National Laboratory	TCPDU	NREL 150 kWt thermochemical pilot development unit
SrO	Strontium oxide	TDLAS	Tunable diode laser absorption spectroscopy
SrTiO ₃	Strontium titanate, the proton conducting material	TDV	Technology demonstration vehicle
SS	Stainless steel	Te	Tellurium
SSA	Specific surface area	TEA	Triethylamine
SSAWG	Storage System Analysis Working Group	TEA ₂ B ₁₂ H ₁₂	Triethylammonium dodecahydrododecaborate
SSC	Structure, system, and component	TEAA	Triethylamine alane adduct
SSI	Single substrate inocula	TEAB	Tetraethyl ammonium borohydride
SSR [®]	Stackable Structural Reactor	TEAH	Tetraethylammonium hydroxide
SSRL	Stanford Synchrotron Radiation Laboratory	TEAMS	tetraethylammonium methane sulfonic
SSRS	Solid-state reactive-sintering	TED	Triethylene-diamine
STCH	Solar Thermochemical Hydrogen	TEDA	Triethylenediamine
STEM	Scanning transmission electron microscopy; science, technology, engineering, and mathematics	TEM	Transmission electron microscopy
STH	Solar-to-hydrogen	TEOM	Tapered element oscillating microbalance
STM	Scanning tunneling microscopy	TEOS	Tetra-ethoxy silane
STMBMS	Simultaneous thermogravimetric modulated beam mass spectrometer	Tf	Trifluoromethane sulfonate, or triflate anion (CF ₃ SO ₃ ⁻)
STP	Standard temperature and pressure	TFA	Trifluoromethanesulfonic acid
STS	Scanning tunneling spectroscopy	TFAc	Trifluoroacetate
STTR	Small Business Technology Transfer	TFE	Tetrafluoroethylene
S _u	Ultimate tensile strength	TFMPA	Trifluoromethylphosphonic acid
SWCNT	Single-walled carbon nanotube	TFMSA	Trifluoromethane sulfonic acid
SWNH	Single-walled nanohorn	TF-RDE:	Thin film rotating disk electrode
SWNT	Single-wall nanotube	tf-Si	Thin film silicon
SwRI [®]	Southwest Research Institute [®]	TFSI	bis(Trifluoromethylsulfonyl)imide
S _y	Yield strength	TFVE	Trifluorovinyl ether
T	Temperature; ton; tonne; Tesla (unit of magnetic induction)	TG	Thermogravimetric, Theory Group
T _{1bar}	Temperature at which equilibrium pressure of hydrogen is 1 bar for a hydrogen exchange reaction	TGA	Thermal gravimetric analysis; thermogravimetric analysis; thermogravimetric analyzer
TAMU	Texas A&M University	TGA-DSC	Thermo-gravimetric analysis-differential scanning calorimetry
TaPO	Tantalum phosphate	TGA-MS	Thermogravimetric analysis-mass spectrometer

XII. Acronyms, Abbreviations and Definitions

THF	Tetrahydrofuran	UCI	University of California, Irvine
Ti	Titanium	UCLA	University of California, Los Angeles
TiCl ₃	Titanium trichloride	UCONN	University of Connecticut
TiF ₃	Titanium trifluoride	UCSB	University of California, Santa Barbara
TiH ₂	Titanium hydride	UEA	Unitized electrode assembly
Ti-IRMOF-16	Titanium (Ti) intercalated IRMOF-16	UEL	Upper explosive limit
TIO	Technology improvement opportunities	UFL	Upper flammability limit
TiO ₂	Titanium dioxide (anatase)	UH	University of Hawaii
<i>Tla</i>	Truncated light-harvesting chlorophyll antenna	UHP	Ultra-high purity
<i>tla1</i>	Mutant of the <i>Tla1</i> gene (GenBank Assession No. AF534570)	UHV	Ultra-high vacuum
<i>tlaR</i>	Mutant of unknown gene with a truncated light-harvesting chlorophyll antenna	UIUC	University of Illinois, Urbana-Champaign
<i>tlaX</i>	Mutant of unknown gene with a truncated light-harvesting chlorophyll antenna	UL	Underwriters Laboratory
TM	Transition metal	ULAM	Ultra-low-angle microtomy
TMA	Trimethylamine; thermal mechanical analyzer	ULSD	Ultra-low sulfur diesel
TMAA	Trimethylamine alane adduct	um, μm	Micrometer(s)
TMAH	Tetramethylammonium hydroxide	UM	University of Michigan
TMB	Trimethylborate	UMC	Unsaturated metal centers; ultramicroporous carbon
TMEDA	Tetramethylethane-1,2-diamine	UN	United Nations
TMOS	Tetramethoxy silane	UNC	University of North Carolina
TMPP	Tetramethoxyphenyl porphyrins	UNLV	University of Nevada, Las Vegas
TMPS	Trimethoxyl phenyl silane	UNLVRF	UNLV Research Foundation
TOS	Time on stream	UNM	University of New Mexico
TPA	Tripropylamine; temperature-programmed adsorption	UNR	University of Nevada, Reno
TPAH	Tetra-n-propylammonium hydroxide	UPD	Underpotentially deposited
TPB	Triple phase boundary	UPE	Ultra-high molecular weight polyethylene
TPD	Tonne(s) per day; thermally programmed desorption; temperature-programmed desorption	UPS	Ultraviolet photoelectron spectroscopy
TPM	Technical performance measure	URFC	Unitized regenerative fuel cell
TPPS	5,10,15,20-tetrakis(4-sulfonatophenyl) porphyrin	U.S.	United States
TPO	Temperature-programmed oxidation	USA	United States of America
TPP	Tetraphenyl porphyrin	USB	Universal serial bus
TPR	Temperature-programmed reduction	USBPIC	Universal serial bus peripheral interface controller
TPRD	Thermally-activated pressure relief device	USC	University of South Carolina; University of Southern California
Trityl	Chemical blocking group used to protect amines	USCAR	United States Council for Automotive Research, U.S. Cooperative Automotive Research
tr. oz.	Troy ounce	USFCC	United States Fuel Cell Council
TV	Test vehicle	USM	University of Southern Mississippi
UC	University of California	USPP	Ultrasoft pseudopotentials
UCB	University of California, Berkeley	USTAG	U.S. Technical Advisory Group
		UTC, UTC FC	United Technologies Corporation Fuel Cells
		UTCP	UTC Power
		UTRC	United Technologies Research Center
		UV	Ultraviolet
		UV-vis	Ultraviolet-visual

V	Vanadium; volt	W/L, W/l	Watt(s) per liter
VAC	Volts alternating current	W/m-K, W/m.K, W/mK	
VANTA	Vertically aligned nanotube arrays		Watt(s) per meter-Kelvin (unit of thermal conductivity)
VASP	Vienna ab initio simulation package		
VaTech	Virginia Polytechnic Institute and State University	WMO	World Meteorological Organization
VBM	Valence band minimum	WO ₃	Tungsten trioxide
VC	Vulcan carbon	WOL	Wedge-opening load
VDC	Volts direct current	W-P	Water-propanol-isopropanol
VDF	Vinylidene fluoride	Wppm	Weight part(s) per million
VDOS	Vibrational density of states	WRI	Western Research Institute
vdW	van der Waals	wt	Weight
vdW-DF	van der Waals density function	Wt	Watt(s) thermal
V-I	Voltage - current	wt%, wt.%	Weight percent (percent by weight)
VIR	Voltage - current - resistance	WTP	Well-to-pump
VIS	Visible light at 400-700 nm	WTT	Well-to-tank
VL	Vacuum level	WTW	Well-to-wheels
VLS	Vapor-liquid-solid	w/v	Weight by volume
V _{mp}	Micropore volume	XANES	X-ray absorption near-edge spectroscopy
VMT	Vehicle miles travelled	XAS	X-ray absorption spectroscopy
VNT	Variable nozzle turbine	XC72	High-surface-area carbon support made by Cabot
VOC	Volatile organic compound; voltage open circuit	XES	X-ray emission spectroscopy
vol	Volume	XPS	X-ray photoelectron spectroscopy; X-ray photon spectroscopy; X-ray photoemission spectroscopy; X-ray photoluminescence spectroscopy
vol%	Volume percent	XRD	X-ray diffraction
V _{pore}	Total pore volume	XRF	X-ray fluorescence
VT	Virginia Tech	Y	Yttrium
W	Tungsten; Watt(s)	yr, YR	Year
WAXD	Wide-angle X-ray diffraction	YSZ	Yttria-stabilized zirconia
WAXS	Wide angle X-ray scattering	Z	Atomic number
WBS	Work breakdown schedule	ZIF	Zeolitic imidazolate framework
WC	Tungsten carbon, tungsten carbide	ZMOF	Zeolite(-type) metal-organic framework
W/cm ²	Watt(s) per square centimeter	Zn	Zinc
W _e	Watt(s) electric	ZnO	Zinc oxide
WGS	Water-gas shift	ZPE	Zero point energy
WGSMR	Water-gas shift membrane reactor	zpp	Zirconium phenyl phosphonate
WGSR	Water-gas shift reactor	Zr	Zirconium
Wh	Watt-hour(s)	ZrO ₂	Zirconium dioxide
W-h/kg	Watt-hour(s) per kilogram	ZrSPP	Zirconium phosphate sulfophenylphosphonate
W-h/L, 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		