

XII. Acronyms and Abbreviations

°C	Degrees Celsius	AlH ₃	Aluminum hydride; alane
°F	Degrees Fahrenheit	Al ₂ O ₃	Aluminum oxide
1-D, 1D	One-dimensional	ALS	Advanced Light Source at Lawrence Berkeley National Laboratory
1Q	First quarter of the fiscal year	AMR	Annual Merit Review
2-D, 2D	Two-dimensional	ANL	Argonne National Laboratory
2-FPTf	2, fluoropyridinium triflate	ANS	American Nuclear Society
2DSM	Dimensionally stable membrane with 2-dimensional laser-drilled hole support	ANSI	American National Standards Institute
2Q	Second quarter of the fiscal year	A ₀	Arrhenius constant, ml/[cm ² -min-atm ^{1/2}]
3-D, 3D	Three-dimensional	AP	As prepared
3DSM	Dimensionally stable membrane with 3-dimensional porous support	APCI	Air Products and Chemicals, Inc.
3Q	Third quarter of the fiscal year	APR	Aqueous-phase reforming
4Q	Fourth quarter of the fiscal year	APRxn	Aqueous phase reaction
8YSZ	8 mol% yttria-stabilized zirconia	APS	Advanced Photon Source
α-AlH ₃	Alpha polymorph of aluminum hydride	APU	Auxiliary power unit
A	Amps	Ar	Argon
Å	Angstrom	a-Si	Amorphous silicon
AAO	Anodic aluminum oxide	a-SiC	Amorphous silicon carbide
AB	Ammonia borane, NH ₃ BH ₃	ASCM	Automotive Systems Cost Model
ABI	Automated ball indentation, Agent-based investment	ASME	American Society of Mechanical Engineers
ABH ₂	Ammonium borohydride, NH ₄ BH ₄	ASMSS	Anode side membrane support structure
ABM	Agent-based modeling	ASPEN	Modeling software, computer code for flowsheet analysis
ABMS	Agent-based modeling and simulation	ASR	Area-specific resistance
AC	Alternating current, Air-cooled	AST	Accelerated stress testing
ACEM	Aberration-corrected electron microscopy	ASTM	ASTM International
ACNT	Aligned carbon nanotube	AT	Ammonia triborane
ACR	Autothermal cyclic reforming	at%,	Atomic percent
AC Transit	Alameda-Contra Costa Transit	ATG	Adenine-Thymine-Guanine, the three base combinations that indicate the first translatable amino acid on the DNA molecule
AD	Anode dew point		
ADM	Archer Daniels Midland Company	atm	Atmosphere
AE	Acoustic emissions	A&TM	Atomistic and thermodynamic modeling
AECL	Atomic Energy Canada, Limited	ATP	Adenosine triphosphate
AEO	Annual Energy Outlook	ATPase	Adenosine triphosphatase
AFM	Atomic force microscopy	ATR	Autothermal reformer; autothermal reforming
Ag	Silver	ATR-FTIR	Attenuated total reflectance Fourier transform infrared
AISI	American Iron and Steel Institute	ATRP	Atom transfer radical polymerization
AK	Alkali	Au	Gold
Al	Aluminum	Avg	Average
Al*	Aluminum particles catalyzed with titanium	B	Boron
AlCl ₃	Aluminum chloride		
ALD	Atomic layer deposition		

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Ba	Barium	BxHy	Polyhedral boranes
bara	Bar absolute	C	Carbon
barg	Bar gauge	Ca	Calcium
bcc	Body-centered cubic	CA	Carbon aerogel
Be	Beryllium	C&S	Codes and Standards
BE	Bloom Energy	CaBr ₂	Calcium bromide
BES	Basic Energy Sciences office within the DOE Office of Science	CaCO ₃	Calcium carbonate
BESR	Bio-ethanol steam reforming	CAD	Computer-aided design
BET	Bruner-Emmett-Teller surface area analysis method	CAE	Computer-assisted engineering
B-H	Borohydride	CaFCP	California Fuel Cell Partnership
BH ₄	Borohydride	CaI	<i>Clostridium acetobutylicum</i> hydrogenase
B-G	Boron-doped graphitic material	Calphad	Calculation of phase diagrams
BisSF	Bisphenol-sulfone	Caltech	California Institute of Technology
BM	Ball-milled, ball mill	CANMET	Canada Center for Mineral and Energy Technology
BMG	Bulk metallic glasses	CaO	Calcium oxide
bmimBF ₄	1-butyl-3-methyl-imidazolium tetrafluoroborate	CaS	Calcium sulfide
bmimCl	1-butyl-3-methyl-imidazolium chloride	CAR	Center of Automobile Research
bmimPF ₆	1-butyl-3-methyl-imidazolium hexafluorophosphate	CBM	Conduction band minimum
BmimOTf	1-butyl-3-methyl-imidazolium triflate	CBN	Carbon-boron-nitrogen
BMPFFP	1-butyl-1-methyl-pyrrolidinium tris(pentafluoroethyl)trifluorophosphate	CBP	Customs and Border Protection
BN	Boron-nitrogen	CBS	Casa Bonita strain, complete basis set
BNHx	Dehydrogenated ammonia-borane	cc	Cubic centimeter(s)
BNL	Brookhaven National Laboratory	CCA	Charge control agent
B-O	Any oxidized boron species, borate	CCD	Charge-coupled device, Central composite design
B ₂ O ₃	Boron oxide; diboron trioxide	CCHSS	Complex Compound Hydrogen Storage System
B(OH) ₃	Boric acid	CCM	Catalyst-coated membrane
Boc	(tert-(B)ut(o)xy(c)arbonyl	cc/min	Cubic centimeters per minute
BOM	Bill of materials	ccp	Cubic close-packing
BOP	Balance-of-plant	CCS	Carbon capture and storage
BoR	Bureau of Reclamation	CCSD(T)	Coupled cluster theory with single and double excitations plus a perturbative correction for triple excitations
¹¹ B-NMR	Boron 11 nuclear magnetic resonance	CCT	Continuous cooling transformation
BP	Formerly British Petroleum, British Petroleum America Production Company	Cd	Cadmium
BPP	Bipolar plate	CD	Cathode dew point
BPS	BiPheny sulfone	CDC	Carbide-derived carbon
BPSH	Bi phenyl sulfone: H Form	CDP	Constant dew point
Br	Bromine	CDP	Composite data product
BR	Back reflector	CDO	Code development organization
Br ₂	Diatomic bromine	Ce	Cerium
BTB	1,3,5-benzenetribenzoate	CEA	Commissariat à l'Énergie Atomique
BTU, Btu	British thermal unit(s)	CEM	Compressor expander motor/module
BU	Boston University	CeO ₂	Ceric oxide
BV	Benzyl viologen	CEPCI	Chemical Engineering's Plant Cost Index

CEQA	California Environmental Quality Act	CpI	<i>Clostridium pasteurianum</i>
CFD	Computational fluid dynamics		[FeFe]- hydrogenase
CFF	Complex coolant fluid	CPM	Cost per thousand impressions
CFFLS	Consortium for Fossil Fuel Liquefaction Science	CPMAS	Cross polarization magic angle spinning
cfm	Cubic feet per minute	CPO, CPOX	Catalytic partial oxidation
CFS	Catalyzed framework structures	Cr	Chromium
CGH ₂	Compressed gaseous hydrogen	CR	Compression ratio
CGO	Cerium gadolinium oxide, Gd-doped CeO ₂	CR5	Counter-rotating-ring-receiver-reactor-recuperator
CGSe ₂	Copper gallium diselenide	CRADA	Cooperative Research and Development Agreement
CIGSe ₂	Copper indium gallium diselenide	CRBJT	Combined reverse-brayton Joule-Thompson
CH ₂	Compressed hydrogen gas	Cs	Cesium
CH ₄	Methane	CS	Constant stoichiometry, Compression set
C ₂ H ₄	Ethylene	CSA	Canadian Standards Association, Cell stack assembly
C ₂ H ₆	Ethane	CSM	Colorado School of Mines, Combined structure & material
C ₃ H ₈	Propane	CSP	Concentrating solar power
CHARM	Cost-effective High-efficiency Advanced Reforming Module	CSR	Catalytic steam reforming, Compressive stress relaxation
CHSCoE	Chemical Hydrogen Storage Center of Excellence	CT	Cell temperature
Chl	Chlorophyll	CTA	Charge transfer agent
CHP	Combined heat and power	CTAB	Cetyl trimethyl ammonium bromide
CIRRUS	Cell Ice Regulation & Removal Upon Start-up	CTC	Concurrent Technologies Corporation
CIS	CuInSe (alloy of copper, indium, and selenium)	CTE	Coefficient of thermal expansion
Cl	Chlorine	CTFE	Chlorotrifluoroethylene
cm	Centimeter	CTTRANSIT	Connecticut Transit
cm ²	Square centimeter	CTV	Chevron Technology Ventures LLC
CMO	Conductive metal oxides	Cu	Copper
CMU	Carnegie Mellon University	cu. in.	Cubic inch
CN	Carbon-nitrogen	CUMC	Coordinatively unsaturated metal centers
CNG	Compressed natural gas	CuO	Cupric oxide, copper(II) oxide
CNT	Carbon nanotube	Cu ₂ O	Cuprous oxide
CO	Carbon monoxide	CV	Cyclic voltammetry; cyclic voltammogram
Co	Cobalt	CVD	Chemical vapor deposition
CO ₂	Carbon dioxide	CVS	Chemical vapor synthesis
COD	Chemical oxygen demand	CY	Calendar year
CoE	Center of Excellence	d	Day(s)
COE	Cost of electricity	DACS	Data acquisition and control system
COG	Coke oven gas	DADB	Diammoniate of diborane, [(NH ₃) ₂ BH ₂] [BH ₄]
CoH	Cost of hydrogen	DAKOTA	Design Analysis Kit for Optimization and Terascale Applications
COPV	Composite overwrapped pressure vessel	DBPDSA	1, 4-dibromo phenylene 2, 5-disulfonic acid
COS	Carbon oxysulfide; Carbonyl sulfide		
CoT	City of Taylor		
CPB	Cyclopentaborazane		

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DC	Direct current	EAN	Ethylammonium nitrate
DDR	A zeolite structure code	E-BOP	Electrical balance-of-plant
DFC	Direct fuel cell	EBSD	Electron backscatter diffraction
DEF	Diethylformamide	EC	European Community; Electro-chemical, Evaporative-cooled
Deg	Degree	ECA	Electrochemical area
DERTF	NREL's Distributed Energy Resources Test Facility	ECE	Electrochemical-chemical-electrochemical
ΔG	Gibbs free energy of reaction	ECHEM FTIR	Electrochemical Fourier transform infrared spectroscopy
DFM	Design for manufacturing	ECS	Electrochemical Society
DFMA	Design for Manufacturing and Assembly	ECSA	Electrochemically active surface area, Electrochemical surface area
DFT	Density functional theory	EDA	Ethylene diamine
DGAC	Dangerous Goods Advisory Council	EDEB	Ethylenediamine bisborane
DHS	Department of Homeland Security	edmimCl	2-ethyl-1,3-dimethyl-imidazolium ethylsulfate
DI	Deionized, De-ionized water	EDS	Energy dispersive X-ray spectroscopy, energy dispersive spectrum
DLA	Defense Logistics Agency	EDTA	Ethylenediamine tetraacetic acid
DLR	Deutsches Zentrum für Luft- und Raumfahrt	EDX	Energy dispersive X-ray
DMA	Dynamic mechanical analysis	EELS	Electron energy loss spectroscopy
DMAc	Dimethyl acetamide	EERE	U.S. DOE Office of Energy Efficiency and Renewable Energy
DMF	n, n-di-methyl formamide	EFR-AHJ	Emergency first responder-authorities having jurisdiction
DMFC	Direct methanol fuel cell	EHC	Electrochemical hydrogen compressor
dmimMeSO ₄	1,3-dimethyl-imidazolium methylsulfate	EIS	Electrochemical impedance spectroscopy
DMPO	5,5-Dimethylpyrroline-N-oxide	EISF	Elastic incoherent structure factor
DMSO	Dimethyl sulfoxide	EM	Electromagnetic, Electrolyzer module
DMTHF	Dimethyltetrahydrofuran	EMF	Electromagnetic field
DNA	Deoxyribonucleic acid	EMI	Electro magnetic interference
DOD	U.S. Department of Defense	eNMR	Electrochemical nuclear magnetic resonance
DOE	U.S. Department of Energy	EOL	End-of-life
DOS	Density of states	EOS	Economies of scale
DOT	U.S. Department of Transportation	EP	Electrochemical polarization, Electric power
DOT/NHTSA	Department of Transportation/National Highway Traffic Safety Administration	EPA	U.S. Environmental Protection Agency
DP	Dew point	EPC	Elevated pressure electrochemical cell
DPS	Delphi Power Systems	EPDM	Ethylene propylene diene monomer
DR	Discount rate	EPR	Electron paramagnetic resonance
DRIFTS	Diffuse reflectance infrared Fourier transform spectroscopy	eRAM	Enterprise remote access monitoring
DS	Dielectric spectroscopy	ESI-MS	Electrospray ionization mass spectrometry
DSC	Differential scanning calorimetry	ESR	Electron spin resonance
DSM	Dimensionally stable membrane	ESRF	European Synchrotron Radiation Facility
DSM-MC	Distance scaling method Monte Carlo	ETA	Event tree analysis
DST	Dynamic Stress Test		
DTA	Differential thermal analysis		
DTE	DTE Energy Ventures		
DTI	Directed Technologies, Inc.		
E_{ad}	Hydrogen adsorption heat		

ETFE	Ethylene-tetrafluoroethylene	FOM	Federated object modeling
EU	European Union	FPA	Fluoroalkyl phosphonic and phosphinic acids
eV	Electron volt	FP-LMTO	Full-potential linear muffin-tin orbital
EVS	Electric Vehicle Symposium and Exhibition	FPTS	Fuel processor test stand
EW	Equivalent weight	FEA	Finite element analysis
EWH	Enthalpy wheel humidifier	FNGP	Freudenberg-NOK General Partnership
F	Fluorine	FRP	Fiber-reinforced polymer
F	Fahrenheit	FRR	Fluoride release rate
F ⁻	Fluorine ion	FS	Free surface, Forest Service
FA	Furfyl alcohol	FSEC	Florida Solar Energy Center
FAA	Federal Aviation Administration	F-SPEEK	Fluorosulfonic acid of polyetheretherketone
FAT	Fleet Analysis Toolkit	F/T	Freeze/thaw
FBMR	Fluidized bed membrane reactor	ft	Feet
FC	Fuel cell	ft ²	Square feet
FCB	Fuel cell bus	ft ³	Cubic feet
fcc	Face-centered cubic	FTA	Federal Transit Administration
FCCJ	Fuel Cell Commercialization Conference of Japan	FTIR	Fourier transform infrared
FCE	FuelCell Energy	FTO	Fluorine-doped tin oxide
F-Cell	Daimler fuel cell vehicle	FW	Formula weight
FCEV	Fuel cell electric vehicle	FWHM	Full width at half maximum
FCFP	FreedomCAR and Fuel Partnership	FY	Fiscal year
FCS	Fuel cell system	ΔG	Free energy of reaction
FCTES ^{QA}	Fuel Cell Testing, Safety and Quality Assurance (an international effort to harmonize fuel cell testing procedures)	g	Gram; acceleration of gravity
FCTESTNET	Fuel Cell Testing and Standardization Network	g/cc	Grams per cubic centimeter
FCTS	Fuel cell test station	g/min	Grams per minute
FCV	Fuel cell vehicle	g/s	Grams per second
FDA	Fleet data acquisition	Ga	Gallium
FE	U.S. DOE Office of Fossil Energy	GA	General Atomics
Fe	Iron	gal	Gallon
Fe ₂ O ₃	Ferric oxide	GaP	Gallium phosphide
FEA	Finite element analysis	GAS-PASS/H	Simulation code for gas-cooled nuclear reactors
FEM	Finite element model	GATOR-GCMOM	Gas, Aerosol, Transport, Radiation, General Circulation, Mesoscale, and Ocean Model
FMEA	Failure mode effects analysis	GB	Grain boundary
FEP	Fluorinated ethylene propylene; Teflon [®]	GC	Gas chromatograph
FER	Fluoride emission rate	GCMC	Grand Canonical Monte Carlo
FFP	Flow field plate	GC/MS	Gas chromatograph/mass spectroscopy
FLiNaK	LiF-NaF-KF eutectic salt	GCTool	Software package developed at ANL for analysis of fuel cells and other power systems
FLUENT	Computer code for computational fluid dynamics	Gd	Gadolinium
FMEA	Failure modes and effects analysis	GDC	Gadolinium-doped ceria
Fmoc	A form of solid-phase peptide synthesis	GDE	Gas diffusion electrode
FNGP	Freudenberg-NOK General Partnership	GDL	Gas diffusion layer
¹⁹ FNMR	¹⁹ Fluorine nuclear magnetic resonance		

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GDM	Gas diffusion media	HAMMER	Hazardous Materials Management and Emergency Response
GDS	Galvanodynamic scan	HATCI	Hyundai-KIA America Technical Center Inc.
Ge	Germanium	HAVO	Hawaii Volcanoes National Park
GE	General Electric	HAZ	Heat affected zone
GES	Giner Electrochemical Systems, LLC	HAZID	Hazard Identification Analysis
GGA	Generalized gradient approximation	HAZOP	Hazards and operability
GGE, gge	Gasoline gallon equivalent	HBr	Hydrogen bromide
GH ₂	Gaseous hydrogen	HBU	Hydrogen based unit
GHG	Greenhouse gas	HBTU	o-Benzotriazol-1-yl-N,N,N',N'-tetramethyluronium hexafluorophosphate
GHSV	Gas hourly space velocity	HCFI	Hydrogen, Fuel Cells and Infrastructure
GIS	Geographic information system	HCG	Hydrogen Coordinating Group
GJ	Gigajoule(s)	HCl, HCL	Hydrochloric acid, Hydrogen chloride
g/kW	Gram(s) per kilowatt	HClO ₄	Perchloric acid
GLAD	Glancing angle deposition	HCNG	Hydrogen – compressed natural gas
GM	General Motors	hcp	Hexagonal close-packed
gm	Gram(s)	HDPE	High-density polyethylene
gm/day	Gram(s) per day	HDS	Hydrogen desulfurization
g/min	Gram(s) per minute	HDSAM	Hydrogen Delivery Scenario Analysis Model
GOS	Global ocean sampling	He	Helium
GPa	Gigapascal(s)	HE	Hydrogen embrittlement
GPC	Gel permeation chromatography	HEI	HyPerComp Engineering Inc.
GPS	Global positioning system	HEHP	High-energy, high-pressure
GREC	Graphite reinforced epoxy composite (IM6 continuously wound)	HEPA	High efficiency particulate air filter
GREET	Greenhouse gases, Regulated Emissions and Energy use in Transportation model	HES	Heat exchange reactor, Hydrogen energy station
GRPE	Working Party on Pollution and Energy	HEV	Hybrid electric vehicle
GTI	Gas Technology Institute	Hf	Hafnium
GTR	Global Technical Regulations	HF	Hydrofluorhydric acid, Hydrogen fluoride, Hartree Fock
GUI	Graphical user interface	HFCIT	Hydrogen, Fuel Cells and Infrastructure Technologies Program
GW	An approximation permitting practical calculation of excitation energies in metals, semi-conductors and insulators	HFCTF	Hawaii Fuel Cell Test Facility
h	Hour(s)	HFCV	Hydrogen fuel cell vehicle
H	Hydrogen	HFP	Hexafluoropropylene
H ⁺	Proton	HFR	High-frequency resistance
H ⁻	Hydride	HFS	hydrogen fueling station
ΔH	Enthalpy of reaction, Enthalpy of hydrogenation	HFSF	High-flux solar furnace
H ₂	Diatomic hydrogen	HGEF	Hawaii Gateway Energy Center
H2A	Hydrogen Analysis project sponsored by DOE	HGM	Hydrogen generation module
H ₂ ICE	Hydrogen internal combustion engine	HGMs	Hollow glass microspheres
H ₂ O	Water	HGV	Hydrogen gaseous vehicle
H2QWG	DOE Hydrogen Quality Working Group	HHICE	Hybrid hydrogen internal combustion engine
H ₂ S	Hydrogen sulfide	HHV	Higher heating value
HAADF	High-angle annular dark-field		
HAC	Hydrogen activation catalyst		

HI	Hydrogen iodide, hydriodic acid	HTSE	High temperature steam electrolysis
HIA	Hydrogen-induced amorphization, Hydrogen implementing agreement	HT-WGS	High-temperature water-gas shift
HIC	Hydrogen-induced cracking	HTXRD	High-temperature X-ray diffraction
HiCON	High CO Conversion Process	HX	Heat exchanger
HIPOC	Hydrogen Industry Panel on Codes	HyARC	Hydrogen Analysis Resource Center
HIx	Blend of hydrogen iodide, iodine, and water	HyDIVE	Hydrogen Dynamic Infrastructure and Vehicle Evolution model
HKUST	1 Cu ₅ (1,3,5-benzenetricarboxylate) ₂	HyDS	Hydrogen deployment system
HLA	High level architecture	HyDRA	Hydrogen Demand and Resource Analysis
HMC	Hyundai Motor Company	HYDROGENIUS	Hydrogen Industrial Use and Storage
HNEI	Hawaii Natural Energy Institute	HyPEP	Hydrogen production efficiency calculation program
HNO ₃	Nitric acid	HyPro, HYPRO	Analysis tool
H ₂ O	Water	HyS	Hybrid sulfur
H ₂ O ₂	Hydrogen peroxide	HYSYS®	Process simulation software by Aspentech
HOPG	Highly-ordered pyrolytic graphite	HyTEC	Hydrogen Technology and Energy Curriculum
HP	High-pressure	HyTRANS	DOE's market simulation model for the transition to hydrogen vehicles
hp	Horsepower	Hz	Hertz
HPA	Heteropoly acid	I	Current
HPC	High-pressure cell	ICAO	International Civil Aviation Organization
HPE	Hybrid photoelectrode	ICAPP	International Congress on Advances in nuclear Power Plants
H-PEMFC	Hydrogen polymer electrolyte membrane fuel cell	ICC	International Code Council
HPLC	High performance liquid chromatography	ICE	Internal combustion engine
HPRD	Hydrogen pressure relief device	ICE/FC	Internal combustion engine/fuel cell
hr	Hour(s)	ICONE	International Conference on Nuclear Energy
HRI	Honda Research Institute	ICP	Inductively coupled plasma
HRL	Hughes Research Laboratory, HRL Laboratories, LLC	ICPAE	Inductively coupled plasma atomic emission
HRTEM	High-resolution transmission electron microscopy	ICP-AES	Inductively coupled plasma atomic emission spectroscopy
HS	Hydrogen sorption	ICSD	Inorganic Crystal Structure Database
HSCoE	Hydrogen Sorption Center of Excellence	ID	Inside diameter
HSDC	Hydrogen Secure Data Center	IE	Intelligent Energy
HSM	Hydrogen storage materials	IEA	International Energy Agency
H ₂ SO ₄	Sulfuric acid	IEA-HIA	International Energy Agency Hydrogen Implementing Agreement
HT	High-temperature	IEC	International Electrotechnical Commission
HTC	BMW Hybrid Technology Corporation	IEC	Ion exchange capacity
HTE	High-temperature electrolysis	IFE	Institute for Energy Technology (Norway)
HTF	Heat transfer fluid, Hydrogen test facility	IGBT	Insulated-gate bipolar transistor
HTFC	High-temperature fuel cell	IGCC	Integrated gasification combined cycle
HTGR	High-temperature gas-cooled reactor		
HTHX	High-temperature heat exchanger		
HTM	High-temperature membrane		
HTM	Hydrogen transport membrane		
HTMWG	High Temperature Membrane Working Group		
HTS	High-temperature shift		

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IL	Ionic liquid	kg/m ³	Kilogram(s) per cubic meter
ILS	Integrated laboratory scale, Instrument landing systems	KH	Potassium hydride
INER	Institute of Nuclear Energy Research	KHTC	hydrotalcites
INERI	International Nuclear Energy Research Initiative	kHz	Kilohertz
INL	Idaho National Laboratory	KIA	Kia Motors Company
INS	Inelastic neutron scattering	KIC	Key industrial collaborators
IP	Intellectual property	kJ	Kilojoule(s)
IPCC	Intergovernmental Panel on Climate Change	KJ300	Ketjen Black EC 300J; a high surface-area carbon support
IPCE	Incident photon conversion to electrons, Incident photon conversion efficiency	kJ/mol	Kilojoule(s) per mole
IPES	Inverse photoemission spectroscopy	km	Kilometer(s)
IPHE	International Partnership for the Hydrogen Economy	KOH	Potassium hydroxide
IP-SOEC	Integrated planar – solid oxide electrolysis cell	kPa	Kilopascal(s)
IPTG	Isopropyl β-D-1-thiogalactopyranoside	kph	Kilometer(s) per hour
IQE	Internal quantum efficiency	K _{TH}	Hydrogen-assisted crack growth threshold
IR	Infrared, internal resistance	kW	Kilowatt(s)
Ir	Iridium	kW _e	Kilowatt(s) electric
IRMOF	Isorecticular metal organic framework	kWh	Kilowatt-hour(s)
IRR	Internal rate of return	kWh/kg	Kilowatt-hour(s) per kilogram
ISO	International Organization for Standardization; International Standards Organization	kWh/L	Kilowatt-hour(s) per liter
ISO TC197	International Standards Organization Technical Committee	kW/kg	Kilowatt(s) per kilogram
ISPRA	Location of the European Joint Research Centre	kW _t	Kilowatt(s) thermal
ITM	Ion transport membrane	L, l	Liter(s)
ITO	Indium tin oxide	La	Lanthanum
ITP	Indium tin phosphate	LAMOX	Lanthanum molybdenum oxide (<i>e.g.</i> , La ₂ Mo ₂ O ₉)
IV	Current-voltage	LANL	Los Alamos National Laboratory
IWI	Incipient wetness impregnation	lb	Pound(s)
J	Joule(s)	LBM	Lattice Boltzmann method
JARI	Japan Automobile Research Institute	lbmol	Pound-mole(s)
JMFC	Johnson Matthey Fuel Cells, Inc.	LBNL	Lawrence Berkeley National Laboratory
JPL	Jet Propulsion Laboratory	LC	Liquid carrier
K	Kelvin	LCF	Low coolant flow
K	Potassium	LCH ₂	Hydrogenated liquid carrier
KAERI	Korea Atomic Energy Research Institute	LCHPP	Low Cost Hydrogen Production Platform (DOE Program Title)
kcal	Kilocalorie(s)	LC-MS	Liquid chromatography-mass spectroscopy
kcal/mol	Kilocalorie(s) per mole	L/D	Length to diameter
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
		LEED	Low-energy electron diffraction
		LEL	Lower explosion limit
		LFL	Lower flammability limit
		L/h, l/h	Liter(s) per hour

LH2, LH ₂	Liquid hydrogen	M31	Arkema's First-Generation Membrane Candidate
LHS	Lawrence Hall of Science		
LHSV	Liquid hourly space velocity, h ⁻¹	M41	Arkema's Second-Generation Membrane Candidate
LHV	Lower heating value		
Li	Lithium	mA	MilliAmps
Li-AB	Lithium amidoborane, Li-NH ₂ -BH ₃	μA	Micro ampere(s)
LiBH ₄	Lithium borohydride	mA/cm ²	Milliamp(s) per square centimeter
LIBS	Laser-induced breakdown spectroscopy	μA/cm ²	Micro ampere(s) per square centimeter
LiH	Lithium hydride	MACRS	Modified accelerated cost recovery schedule
LIM	Liquid injection molding, liquid injection moldable	MAE	Modal acoustic emissions
Li ₃ N	Lithium nitride	MALDI	Matrix-assisted laser desorption/ionization
LLC	Limited liability company		
LLNL	Lawrence Livermore National Laboratory	MARKAL	Market Allocation Model – A generic, multi-sector energy model developed by the Energy Technology Systems Analysis Program of the International Energy Agency
LMWO	Lanthanum molybdenum tungsten oxide (e.g., La ₂ Mo _{1.8} W _{0.2} O _{9-x})		
L/min, l/min	Liter(s) per minute	MAS	Magic angle spinning
LN ₂	Liquid nitrogen	MAS ¹¹ B-NMR	Magic angle spinning boron-11 nuclear magnetic resonance spectroscopy
LPG	Liquefied petroleum gas		
LQ*	Dehydrogenated liquid carrier	MAS-NMR	Magic angle spinning nuclear magnetic resonance
LQ*H2	Hydrogenated liquid carrier		
LRS	Laser raman spectroscopy	MBMS	Molecular beam mass spectrometry
LSC	Lanthanum strontium cobalt oxide, (La, Sr)CoO ₃ , strontium-doped lanthanum cobaltite, La _{0.8} Sr _{0.2} CoO ₃₊	M-BOP	Mechanical balance-of-plant
		MC	Monte Carlo, Model compound
		mC ²	Multi-component composite membrane
LSCF	Lanthanum strontium cobalt iron oxide – (La, Sr)(Co, Fe)O ₃	MCEL	Millenium Cell, Inc.
LSCM	Lanthanum strontium chromium manganese oxide, (La, Sr)(Cr, Mn)O ₃	MCFC	Molten carbonate fuel cell
LSM	Lanthanum strontium manganese oxide, (La, Sr)MnO ₃ , strontium-doped lanthanum manganite, La _{0.8} Sr _{0.2} MnO ₃₊	MD	Molecular dynamics
		M _d	Temperature for formation of strain-induced martensite
LSV	Lanthanum strontium vanadate, Linear sweep voltammetry	MDES	Methyl-diethoxy silane
		mdip	5,5'-methylene-di-isophthalate
LST	Lanthanum strontium titanium oxide, (La, Sr)TiO ₃	MEA	Membrane electrode assembly
LT	Low-temperature	MeAB	Methylamine borane
LTDMS	Laser induced thermal desorption mass spectrometry	MEC	Microbial electrolysis cell, Minimum explosive concentration
		MEI	Makel Engineering
		MEIC	Mixed electronic and ionic conducting (membranes)
LWR	Light water reactor		
LVVWD	Las Vegas Valley Water District	MFC	Microbial fuel cell, Mass flow controller
m	Meter(s)	MFE	Membrane-free extract
M	Mole, molar	MFI	A zeolite structure code
M	Million	Mg	Megagram(s)
m ²	Square meter(s)	μg	Microgram(s)
m ² /g	Square meter(s) per gram	mg	Milligram(s)
m ² /s	Square meter(s) per second	mg/cm ²	Milligram(s) per square centimeter
m ³	Cubic meter(s)	MgCl ₂	Magnesium chloride

XII. Acronyms and Abbreviations

MGD	Media gravimetric density	ms	Millisecond(s)
MgH ₂	Magnesium hydride	mS/cm	Milli-Siemen(s) per centimeter
MgO	Magnesium oxide	MS	Mass spectroscopy, mass spectrometry
Mg(OH) ₂	Magnesium hydroxide	MSA	Metropolitan statistical area, Methanesulfonic Acid
mgPt/cm ²	Milligrams of platinum per square centimeter	MS-EVB	Multi-state empirical valence bond method for simulating proton transport via the Grotthuss shuttling mechanism
MH	Metal hydride, tin metal hydride, membrane humidifier	MS-H ₂	Hydrogen mass spectrometry
MHC	Metal hydride-based compressor	MSM	Macro-System Model
MHCoE	Metal Hydride Center of Excellence	M/TC	Metal-doped templated carbon
MHz	Megahertz	MTI	Mechanical Technology, Inc.
mi	Mile(s)	mtorr	millitorr
MIE	Minimum ignition energy	MTS	Membrane test system, material test systems
MIEC	Mixed ionic and electronic conduction	μV	Micro volt(s)
mi/kg	Mile(s) per kilogram	mV	Millivolt(s)
mil	Millimeter(s)	MV	Methyl viologen
min	Minute(s)	mW	Milliwatt(s)
MIT	Massachusetts Institute of Technology	MW	Megawatt(s)
MiTi [®]	Mohawk Innovative Technologies Inc.	MW	Molecular weight
MJ	Megajoule(s)	mΩ	Milli-ohm(s)
mL, ml	Milliliter(s)	MΩ	Mega-ohm(s)
ML	Monolayer	mΩ/cm ²	Milli-ohm(s) per square centimeter
μm	Micrometer(s); micron(s)	μΩ-cm ²	Micro-ohm(s) - square centimeter
mmol	Millimole(s)	mW/cm ²	Milliwatt(s) per square centimeter
MMP	MetaMateria Partners LLC	MWCNT	Multiple-wall carbon nanotube
MM-SE	Mueller matrix spectro-ellipsometry	MW _e	Megawatt(s) electric
MMSCFD	Million standard and cubic feet/day	MWNT	Multi-wall carbon nanotubes
Mn	Manganese	MW _{th}	Megawatt(s) thermal
MnO	Manganese (II) oxide	MYPP	Multi-Year Program Plan (the HFCIT Program's Multi-Year Research, Development and Demonstration Plan), Multi-year product plan
Mn ₂ O ₃	Manganese (III) oxide	MYRDD, MYRD&DP	Multi-Year Research, Development and Demonstration Plan
MOF	Metal-organic framework	N	Nitrogen atom
mol	Mole(s)	N	Newton (unit of force)
MOZART	Model for OZone And Related Trace species chemical-transport model of the global atmosphere	N/cm ²	Newton(s) per square centimeter
MPa	Megapascal	N112	Nafion [®] 1100 equivalent weight, 2 millimeter thick membrane
MPG, mpg	Mile(s) per gallon	N ₂	Diatomic nitrogen
mph	Mile(s) per hour	Na	Sodium
MPL	Microporous layer	NA	North American
MPP	Maximum power point	Na ₃ AlH ₆	Trisodium hexahydroaluminate
MPPO	Modified poly(phenylene oxide)	NaAlH ₄	Sodium aluminum hydride; sodium tetrahydroaluminate; sodium alanate
mpy	Mils per year	NaBH ₄	Sodium borohydride
MQMAS	Multiple quantum magic angle spinning		
MR	Membrane reactor		
MRCAT	Materials Research Collaborative Access Team		
MRT	Membrane Reactor Technologies		

NaBO ₂	Sodium metaborate	NHI	Nuclear Hydrogen Initiative
NACE	National Association of Corrosion Engineers	NHTSA	National Highway Traffic Safety Administration of the U.S. Department of Transportation
NaCl	Sodium chloride	Ni	Nickel
Nafion [®]	Registered Trademark of E.I. DuPont de Nemours	NILS	Normal interstitial lattice sites
NaH	Sodium hydride	NiMH	Nickel metal hydride
NaOH	Sodium hydroxide	NIST	National Institute of Standards and Technology
Na ₂ S	Sodium sulfide	NL	Normal liter(s)
NanoPE	Nano photo electrolyzer	nm	Nanometer(s)
NASFM	National Association of State Fire Marshals	NMHC	Non-methane hydrocarbons
NASA	National Aeronautics and Space Administration	NMP	N-methylpyrrolidone
NC-MS	Noncovalent mass spectrometry	NMR	Nuclear magnetic resonance
NCMS	National Center for Manufacturing Sciences	Nm ³	Normal cubic meter(s)
NCN	Nano capillary network	NMT	New Mexico Tech
NCNR	NIST Center for Neutron Research	NNA	Non-North American
NDC	New delivery concept, Naphthalene-2,6-dicarboxylate	NNA NG	Non-North American natural gas
NDTE	Non-destructive testing and evaluation	NNIF	NIST neutron imaging facility
NE	U.S. DOE Office of Nuclear Energy, Science and Technology	Nm ³	Normal cubic meter(s)
NEB	Nudged elastic band	NMR	Nuclear magnetic resonance
NEDO	New Energy and Industrial Technology Development Organization (Japan)	NNA	Non-North American
NEED	National Energy Education Development Project	NO ₂	Nitric oxide
NEMS	National Energy Modeling System	N ₂ O	Nitrous oxide
NEPA	National Environmental Policy Act	NOx	Oxides of nitrogen
NERI	Nuclear Energy Research Initiative	NFPA	National Fire Protection Association
NERI-C	Nuclear Energy Research Initiative-Consortium	NPC	Nanoporous carbon
NESSHY	Novel efficient solid storage of hydrogen	NPD	Neutron powder diffraction
NETL	National Energy Technology Laboratory	NPM	Nanostructured polymeric materials
NFC	Near-frictionless carbon	NPPD	n-phenyl-phenylenediamine
NFCRC	National Fuel Cell Research Center	NPS	National Park Service
NFPA	National Fire Protection Association	NPT	Normal pressure and temperature
NFS	Nano-framework structured	NPV	Net present value
NG	Natural gas	NR ₃	Tertiary amine
NGCC	Natural gas combined cycle	NRC	National Research Council
NGNP	Next Generation Nuclear Plant	NRC-IFCI	National Research Council's Institute for Fuel Cell Innovation
NGO	Non-government organization	NREL	National Renewable Energy Laboratory
NH ₃	Ammonia	NSTF	Nanostructured thin film
NHA	National Hydrogen Association	NSTFC	Nano-structured thin film catalyst
NHE	Normal hydrogen electrode	NTP	Negative thermal expansion
NHFC4	National Hydrogen and Fuel Cells Codes and Standards Coordinating Committee	NVS	Neutron vibrational spectroscopy
		NWM	"Natural Water Management", UTC Power's system and cell stack design which utilizes evaporative cooling in the cell stack assembly
		NWS	National Weather Service
		NZVI	Nano zerovalent iron

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O	Oxygen	PCI	Pressure-composition isotherm
O ₂	Diatomic oxygen	PCM	Power control module
O/C	Oxygen-to-carbon ratio	PCN	Porous coordination network
OCP	Open circuit potential	PCR	Polymerase chain reaction
OCV	Open circuit voltage	PCT	Pressure concentration temperature
o.d.,OD	Outer diameter	Pd	Palladium
ODA	Oxygenated form of diamine	PdAg	Palladium-silver alloy
OEC	Oxygen evolving complex	PdCu	Palladium-copper alloy
OEM	Original equipment manufacturer	PDA	Personal digital assistant
OER	Oxygen evolution reaction	PDF	Probability density function, Pair distribution function
OH ⁻	Hydroxyl radical	PdHg/CF	Carbon foam doped with palladium-mercury compound
OHFCIT	Office of Hydrogen, Fuel Cells, and Infrastructure Technologies	PDMS	Polydimethylsiloxane
O&M	Operation and maintenance	PDU	Process development unit
OMB	Office of Management and Budget	PEAR	Power and Energy Analytic Resources
OMC	Ordered mesoporous carbon	PEC	Photoelectrochemical, Photoelectrochemical cell
O/O	Oxygen-to-oxygen	PECVD	Plasma-enhanced chemical vapor deposition
ORNL	Oak Ridge National Laboratory	PED	Pulsed electrodeposition
ORNL-HTML	Oak Ridge National Laboratory High Temperature Materials Laboratory	PEEK	Polyether ether ether ketone
ORR	Oxygen reduction reaction	PEFC	Polymer electrolyte fuel cell
OSC	Oxygen storage capability	PEFC	Proton exchange fuel cell
OSHA	U.S. Occupational Safety and Health Administration	PEGS	Prototype electrostatic ground state
OSM	Oregon Steel Mills, Optical scatterfield microscopy	PEI	Polyetherimide
OSU	Ohio State University	PEKK	Poly (ether ketone ketone)
OTM	Oxygen transport membrane	PEM	Polymer electrolyte membrane
ΔP	Pressure drop, pressure change	PEM	Proton exchange membrane
P	Phosphorus	PEMFC	Polymer electrolyte membrane fuel cell
P	Pressure	PEMFC	Proton exchange membrane fuel cell
Pa	Pascal(s)	PES	Polyether sulfone, Polyethersulfone-polyimide copolymer, Potential energy surface
PA	Phenylacetylene, Polyamide	PET	Polyethylene teraphthalate
PADD	Petroleum Administration for Defense District	PFA	Perfluoroalkoxy (a type of fluoropolymer)
PAFC	Phosphoric acid fuel cell	PFD	Process flow diagram
PANI	Polyaniline	PGSE	pulse field gradient spin echo
PA/PBI	Phosphoric-acid-doped polybenzimidazole	PFSA	Perfluorinated sulfonic acid, perfluorosulfonic acid
PAR	Photosynthetically-active radiation	PGAA	Prompt-gamma activation analysis
PAS	Photoactive semiconductor	PGE	Platinum group element
PAW	Projector augmented wave	PG&E	Pacific Gas and Electric Company
Pb	Lead	PGM	Precious group metal, Platinum group metal
PB	Polyborazylene	PHA	Process hazard analysis, Preliminary hazard analysis
PBI	Polybenzimidazole	PHEV	Plug-in hybrid electric vehicle
PBPDSA	poly(biphenylene disulfonic acid)		
PC	Personal computer		
PCHD	Poly(cyclohexadiene)		

PI	Principal investigator	PSII	Photosystem II
P&ID	Piping and instrumentation diagram, Process and instrumentation diagram	PSOFC	Planar solid oxide fuel cells
PIL, pIL	Protic ionic liquid	PSU	Pennsylvania State University
PIM, pIM	Protic ionic membrane	Pt	Platinum
Pl	Platinum	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
PLC	Programmable logic controller	Pt/AX-21	Pt-doped microporous carbon AX-21
PM	Precious metal, such as platinum; Peroxide mitigation	Pt-MM	Platinum mixed metal
PM ₁₀	Particulate matter with diameters of 10 micrometers or less	P-T	Pressure-temperature
PM _{2.5}	Particulate matter with diameters of 2.5 micrometers or less	PTA	Phosphotungstic acid
PNNL	Pacific Northwest National Laboratory	Pt/C	Platinum/carbon
pO ₂	Oxygen partial pressure	PTFE	Teflon [®] – poly-tetrafluoroethylene
POC	Proof-of-concept	Pt-NH	Platinum decorated carbon nanohorn
POCOP	<i>P,P-bis(1,1-dimethylethyl)-3-[[bis(1,1-dimethylethyl)phosphino]oxy]phenyl ester</i>	PtO	Platinum oxide
POM	Polyoxometallate	PtO ₂	Platinum dioxide
POSS	Polyhedral oligomeric silsesquioxane	PtRu	platinum ruthenium
POTG	Partial oxidation gas turbine	Pt-SWNH	Platinum decorated single-walled nanohorn
POX	Partial oxidation	PTW	Pump-to-wheels
ppb	Parts per billion	PV	Photovoltaic
ppbv	Part(s) per billion by volume	PVD	Physical vapor deposition
PPDSA	Poly (p-phenylene disulfonic acid)	PVDF	Polyvinylidene fluoride
PPI	Pore(s) per inch	PVP	Polyvinylpyrrolidone
ppm, PPM	Part(s) per million	PVT	Pressure-volume-temperature
ppmv	Part(s) per million by volume	PWG	Pipeline Working Group
ppmw	Part(s) per million by weight	PXD	Powder X-ray diffraction
PPO	Phenyl phosphine oxide	PyC	4-pyrazole carboxylate
PPS	Polyphenylenesulfide	PzDC	2,8-pyrazabole dicarboxylate
PPSA	Poly (p-phenylene sulfonic acid)	Q	Neutron momentum transfer
PPSU	Polyphenylsulfone	Q1, Q2, Q3, Q4	Quarters of the fiscal year
PPy	polypyrrole	QCM	Quartz crystal microbalance
PrOx	Preferential oxidation	QENS	Quasielastic neutron scattering
PR	Pressure ratio	QRA	Quantitative risk assessment
PS	Photosystem, Proton sponge (bis-(dimethylamino)naphthalene)	R	Universal or ideal gas constant, 8.314472 J · K ⁻¹ · mol ⁻¹
PSA	Pressure swing adsorption, Pressure sensitive adhesive	RA	Reduction of area
PSAT	Powertrain Systems Analysis Toolkit, a vehicle simulation software package developed at Argonne National Laboratory	RAS	Russian Academy of Sciences
PSD	Particle size distribution	R&D	Research and development
psi	Pound(s) per square inch	RC	Research cluster
psia	Pound(s) per square inch absolute	RCAG	Remote communications air to ground
psig, PSIG	Pound(s) per square inch gauge	RCD	Rating current density (maximum power)
		RCLR	Radio communications link repeater
		RDC	Resource Dynamics Corporation
		RD&D	Research, development & demonstration
		RDE	Rotating disk electrode

XII. Acronyms and Abbreviations

Re	Rhenium	SCFH	Standard cubic feet per hour
ReaxFF	Reactive force field large-scale molecular dynamic calculations	SCFM	Standard cubic feet per minute
RF, rf	Radio frequency	SCI-MS-EVB	“Self Consistent Iterative” approach to MS-EVB simulations that include more than one proton.
RF	Roughness factor	SCPO	Staged catalytic partial oxidation
RFP	Request for proposals	SCR	Selective catalytic reduction, semiconductor rectifier
RGA	Residual gas analyzer	S/cm	Siemen(s) per centimeter
RH	Relative humidity, Rohm and Haas	ScSZ	Scandia-stabilized zirconia
Rh	Rhodium	SD	Standard deviation, System dynamics
ρ_a	Apparent density of activated carbon	SDAPP	Sulfonated diels-alder polyphenylene
RIXS	Resonant inelastic X-ray scattering spectra	SDC	Samarium-doped ceria
RHE	Reference hydrogen electrode; reversible hydrogen electrode	SDE	SO ₂ -depolarized electrolyzer
ROI	Return on investment	SDO	Standards Development Organization
RP	Refined petroleum	SDT	Simultaneous differential scanning calorimeter and thermalgravimetric analyzer
RPI	Rensselaer Polytechnic Institute	Se	Selenium
rpm	Revolution(s) per minute	sec	Second(s)
RRDE	Rotating ring disc electrode	SEC	Size exclusion chromatography
RRT	Round-robin testing	SECA	Solid State Energy Conversion Alliance
RPSA	Rapid pressure swing adsorption	SECM	Scanning electrochemical microscope
RRFCS	Rolls Royce Fuel Cell Systems	SEM	Scanning electron microscopy, scanning electron microscope
RSOFC	Reversible solid oxide fuel cell	SERC	Schatz Energy Research Center
RT	Room temperature	SFC2	SrFeCo _{0.5} O _x
RTR	Radio transmit and receive	SFT	Sr-Fe-Ti oxide
Ru	Ruthenium	SFA	Sulfonic acid
s	Second(s)	SGD	System gravimetric density
S	Siemen(s)	SHE	Standard hydrogen electrode
S	Sulfur	SHGR	Solar hydrogen generation research
-S	Sulfur-deprived	Si	Silicon
SA	Surface area	S-I	Sulfur-iodine
SAE	Society of Automotive Engineers	SI	Sulfur-iodine
SAM	Scanning auger microscopy	SiC	Silicon carbide
SANS	Small angle neutron scattering	SiO ₂	Silicon dioxide
SAS	Styrene-acrylonitrile-vinylsulfate	sL	Standard liter (0°C, 1 atm)
SASSP	Solvent assisted solid state processing	SLAC	Stanford Linear Accelerator Center
SAXS	Small angle X-ray scattering	slpm, slm	Standard liter(s) per minute
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
SBP	Solution-based processing	SNL	Sandia National Laboratories
SBU	Secondary building units	SNLL	Sandia National Laboratories Livermore
Sc	Scandium	SNR	Signal-to-noise ratio
S/C	Steam-to-carbon ratio	SLPH	Standard liter per hour
sccm, SCCM	Standard cubic centimeter(s) per minute		
SCF, scf	Super critical fluid, Standard cubic feet		
scfd	Standard cubic feet per day		

SLPM	Standard liter per minute	STMBMS	Simultaneous thermogravimetric modulated beam mass spectrometer
SO ₂	Sulfur dioxide	STP	Standard temperature and pressure
SOC	State-of-charge	STS	Scanning tunneling spectroscopy
SOEC	Solid oxide electrolysis cell; Solid oxide electrolyzer cell	STTR	Small Business Technology Transfer
SOFC	Solid oxide fuel cell	SUNY-ESF	State University New York Environmental Science Forestry
SOFEC	Solid oxide fuel-fed electrolysis cell	SV	Space velocity
SOM	Solid-oxide oxygen-ion-conducting membrane	SVD	System volumetric density
SOW	Statement of work	SWCNT	Single-walled carbon nanotube
SO _x	Oxides of sulfur	SWNH	Single-walled nanohorn
sPAES	Sulfonated poly(arylene ether sulfone)	SWNT	Single-wall nanotube
SPD	Surface packing densities	SwRI [®]	Southwest Research Institute
SPE	Solid phase epitaxial	SYT	Yttrium-doped strontium titanate
SPEK	Sulfonated poly-etherketone-ketone	T	Temperature
SPEKK	Sulfonated polyether(ether ketone ketone)	T _{1bar}	Temperature at which equilibrium pressure of hydrogen is 1 bar for a hydrogen exchange reaction
sPEEK	Sulfonated poly(ether ether ketone)	t	Time
SPEX	Type of milling machine	Ta	Tantalum
SPM	Scanning probe microscope	TA	Terephthalic acid
sPOSS	sulfonated octaphenyl polyhedral oligomeric silsesquioxanes	TACAN	Tactical air navigation aid
S-PPSU	Sulfonated polyphenylsulfone	TAMU	Texas A&M University
SPR	Solid particle receiver	TBA-PF ₆	Tetra- <i>n</i> -butylammonium hexafluorophosphate
sq. in.	Square inch(es)	TBD	To be determined
Sr	Strontium	TC	Thermocouple, Templated carbon, Technical committee
SRM	Steam reforming	TCCR	Transparent, conducting and corrosion resistant
SRNL	Savannah River National Laboratory	TCPDU	NREL 150 kWt thermochemical pilot development unit
SrO	Strontium oxide	TCNE	Tetracyanoethylene
SrTiO ₃	Strontium titanate, the proton conducting material	TDV	Technology demonstration vehicle
SS	Stainless steel	TEAA	Triethylamine alane adduct
SSA	Specific surface area	TEAB	Tetraethyl ammonium borohydride
SSM	stress strain microprobe	TEDA	Triethylenediamine
SSNMR	Solid-state nuclear magnetic resonance	TEAH	Tetraethylammonium hydroxide
SSP	Solid-state processing	TEM	Transmission electron microscopy
SSR [™]	Stackable Structural Reactor	TEOM	Tapered element oscillating microbalance
SSRL	Stanford Synchrotron Radiation Laboratory	TEOS	Tetra-ethoxy silane
SSV	Shift space velocity	Tf	Trifluoromethane sulfonate, or triflate anion (CF ₃ SO ₃ ⁻)
STA	Silicongstic acid, Sulfonated terephthalic acid	TFA	Trifluoromethanesulfonic acid
STC	Standard test conditions	TFAc	Trifluoroacetate
STCH	Solar thermochemical to hydrogen	TFE	Tetrafluoroethylene
STEM	Scanning transmission electron microscopy	TFMSA	Trifluoromethane sulfonic acid
STH	Solar-to-hydrogen	TF-RDE	Thin film rotating disk electrode
STM	Scanning tunneling microscopy		

XII. Acronyms and Abbreviations

TFSI	Trifluorosulfimide	UCSB	University of California, Santa Barbara
TFVE	Trifluorovinyl ether	UEA	Unitized electrode assembly
tf-Si	Thin film silicon	UH	University of Hawaii
TG	Thermogravimetric, Theory Group	UHP	Ultra-high purity
TGA	Thermal gravimetric analysis, Thermogravimetric analysis, Thermogravimetric analyzer	UHV	Ultra-high vacuum
TGA-DSC	Thermo-gravimetric analysis-differential scanning calorimetry	UIUC	University of Illinois, Urbana-Champaign
TGA-MS	Thermogravimetric analysis-mass spectrometer	UL	Underwriters Laboratory
TG-DTA	Thermo-gravimetric/differential thermal analyzer	um	Micrometer(s)
THF	Tetrahydrofuran	UM	University of Michigan
Ti	Titanium	UMC	Unsaturated metal centers
TiO ₂	Titanium dioxide (anatase)	UMSL	University of Missouri – St. Louis
<i>Tla</i>	Truncated light-harvesting chlorophyll antenna	UNB	University of New Brunswick
<i>tla1</i>	Mutant of the <i>Tla1</i> gene (GenBank Assession No. AF534570)	UNC	University of North Carolina
<i>tlaR</i>	Mutant of unknown gene with a truncated light-harvesting chlorophyll antenna	UNECE	United Nations Economic Commission for Europe
<i>tlaX</i>	Mutant of unknown gene with a truncated light-harvesting chlorophyll antenna	UNLV	University of Nevada, Las Vegas
TM	Transition metal	UNLVRF	UNLV Research Foundation
TMAA	Trimethylamine alane adduct	UNM	University of New Mexico
TMAH	Tetramethylammonium hydroxide	UNR	University of Nevada, Reno
TMB	Trimethylborate	UPS	Ultraviolet photoelectron spectroscopy
TMPS	Trimethoxyl phenyl silane	U.S.	United States
TMS	Thermal management system	USCAR	United States Council for Automotive Research
TPA	Tripropylamine, Temperature- programmed adsorption	USFCC	United States Fuel Cell Council
TPAH	Tetra-n-propylammonium hydroxide	USPP	Ultrasoft pseudopotentials
TPD	Tons per day	USPS	United States Postal Service
TPD	Temperature-programmed desorption	UT	Ultrasonic testing
TPPS	5,10,15,20-tetrakis(4-sulfonatophenyl) porphyrin	UTC	United Technologies Corporation
TNA	Titania nanotube arrays	UTRC	United Technologies Research Center
TPO	Temperature-programmed oxidation	UV	Ultraviolet
TPR	Temperature-programmed reduction	UV-vis	Ultraviolet-visual
tr. oz.	Troy ounce	V	Vanadium
TSA	Temperature swing adsorption	V	Volt
UC	University of California	VAC	Volts alternating current
UCB	University of California, Berkeley	VANTA	Vertically-aligned nanotube arrays
UCI	University of California, Irvine	VASP	Vienna ab initio simulation package
UCLA	University of California, Los Angeles	VBM	Valence band minimum
UCONN	University of Connecticut	VDC	Volts direct current
		VDF	Vinylidene fluoride
		VDOS	Vibrational density of states
		vdW	van der Waals
		VFS	Vehicle fueling station
		V(H ₂)	Volumetric hydrogen storage capacity
		VHTR	Very high temperature gas-cooled nuclear reactor
		VHTS	Virtual high-throughput screening
		V-I	Voltage – current

VIS	Visible light at 400-700 nm	Wppm	Weight part per million
V_{mp}	Micropore volume	Wt	Watt(s) thermal
VMT	Vehicle miles travelled	wt	Weight
VNT	Variable nozzle turbine	wt%	Weight percent (percent by weight)
VOC	Volatile organic compound; Voltage open circuit	WTP	Well-to-pump
vol	Volume	WTT	Well-to-tank
V_{pore}	Total pore volume	WTW	Well-to-wheels
vol%	Volume percent	WU	Water uptake
VOR	Very high frequency omnidirectional range	w/v	Weight by volume
VTNA	Volvo Trucks North America	XC72	High-surface-area carbon support made by Cabot
Ω	Ohm(s)	XAFS	X-ray absorption fine structure
W	Tungsten	XANES	X-ray absorption near-edge spectroscopy
W	Watt(s)	XAS	X-ray absorption spectroscopy
WAXD	Wide-angle X-ray diffraction	XPS	X-ray photoelectron spectroscopy, X-ray photon spectroscopy, X-ray photoemission spectroscopy
WBS	Work breakdown schedule	XPS-UPS	X-ray photoelectron-ultraviolet photoelectron spectroscopy
WC	Tungsten carbon	XRD	X-ray diffraction
We	Watt(s) electric	XRF	X-ray fluorescence
W/F	Ratio of catalyst dosage to feed flow rate	Y	Yttrium
WG	Working group	yr, YR	Year
WG-12	Working Group 12	YSZ	Yttria-stabilized zirconia
WGS	Water-gas shift	Z	Atomic number
WGSMR	Water-gas shift membrane reactor	Zn	Zinc
Wh	Watt-hour(s)	ZnO	Zinc oxide
$W(H_2)$	Gravimetric hydrogen storage capacity	zpp	Zirconium phenyl phosphonate
W-h/kg	Watt-hour(s) per kilogram	Zr	Zirconium
W-h/L, Wh/liter, Wh/L	Watt-hour(s) per liter	ZrO ₂	Zirconium dioxide
WHSV	Weight hourly space velocity	ZrSPP	Zirconium phosphate sulfophenylphosphonate
Wind2H2	Wind to hydrogen demonstration project	ZVI	Zerovalent iron
W/kg	Watt(s) per kilogram		
W/L, W/l	Watt(s) per liter		
WO ₃	Tungsten trioxide		
WOL	Wedge opening load		