Weber, M. J. “Appendices”
Handbook of Laser Wavelengths.
Ed. Marvin J. Weber
Boca Raton: CRC Press LLC, 1999

Appendices

APPENDIX 1

Abbreviations, Acronyms, Initialisms, and Common Names for Types and Structures of Lasers and Amplifiers

APM	—	additive pulse mode-locked (laser)
ASE	—	amplified spontaneous emission
ASRL	—	anti-Stokes Raman laser
AWI	—	amplification without inversion
BC	—	buried crescent (laser)
BFA	—	Brillouin fiber amplifier
BGSL	—	broken-gap superlattice (laser structure)
BH	—	buried heterostructure (laser)
BIG	—	bundle-integrated-guide (laser)
BOG	—	buried optical guide (laser)
BRS	—	buried ridge structure (laser)
BVSIS	—	buried V-groove substrate inner stripe (laser)
C^3	—	cleaved coupled cavity (laser)
CBH	—	circular buried heterostructure (laser)
CC-CDH	—	current confined constricted double hetrostructure (laser)
CCGSE	—	concentric-circle grating surface emitting (laser)
CCL	—	color center laser
CDH	—	constricted double heterostructure (laser)
CEL	—	correlated emission laser
CMBH	—	capped-mesa buried-heterostructure (laser)
COIL	—	chemical oxygen-iodine laser
CPA	—	chirped pulse amplification
CPM	—	colliding-pulse mode-locked (laser)
CPM	—	corrugation-pitch-modulated (laser)
CRL	—	compact rugged laser
CSP	—	channeled-substrate planar (laser)
CVL	—	copper vapor laser
CW	—	continuous wave (laser)
D^3	—	directly doubled diode (laser system)
DASAR	—	darkness amplification by stimulated absorption of radiation
DBR	—	distributed Bragg reflector (laser)
DC	—	direct current (continuous output)
DCFL	—	double clad fiber laser
DCPBH	—	double channel planar buried heterostructure (laser)
DDS	—	deep-diffuse stripe (laser)

Appendix 1—*continued*

Abbreviations, Acronyms, Initialisms, and Common Names for Types and Structures of Lasers and Amplifiers

DD-WGM	—	dye-doped whispering galley mode (laser)
DFB	—	distributed feedback (laser)
DFC	—	distributed forward coupled (laser)
DH	—	double-heterostructure (laser)
DPL	—	diode-pumped laser
DPSSL	—	diode-pumped solid-state laser
DQW	—	double quantum well (laser)
DR	—	distributed reflector (laser)
DS	—	diffused stripe (laser)
DSM	—	dynamic-single-mode (laser)
ECDL	—	external cavity diode laser
EDFA	—	erbium-doped fiber amplifier
EEDL	—	edge-emitting diode laser
EFA	—	erbium fiber amplifier
EML	—	electroabsorption modulated laser
ESA-FEL	—	electrostatic-accelerator free-electron laser
ETDL	—	energy transfer dye laser
ETU	—	energy transfer upconversion (laser)
excimer	—	excited dimer (laser)
F-(center)	—	Farbe, German word for color (laser)
FCSEL	—	folded-cavity surface-emitting laser
FEDL	—	flashlamp-excited dye laser
FEL	—	free electron laser
FEM	—	free-electron maser
FG-ECL	—	fiber-grating external-cavity laser
FSFL	—	frequency-shifted feedback laser
GC	—	grating coupled (laser)
GDL	—	gas dynamic laser
GRINSCH	—	graded-index separate confinement heterojunction (laser)
GSE	—	grating-surface-emitting (laser)
GVL	—	gold vapor laser
HAP	—	high average power (laser)
HDL	—	homodyne laser
HEL	—	high enery laser
HENE	—	He-Ne (gas laser)
HPP	—	high peak power (laser)
HRO	—	heteroepitaxial ridge overgrown (laser)

Appendix 1—*continued*

Abbreviations, Acronyms, Initialisms, and Common Names for Types and Structures of Lasers and Amplifiers

ICF	—	inertial confinement fusion (laser)
LASER	—	light amplification by stimulated emission of radiation
LD	—	laser diode
LEC	—	long external cavity (laser)
LM-MQW	—	lattice-matched multiple quantum well (laser)
LWI	—	lasing without inversion
MASELA	—	matrix-addressable surface-emitting-laser array
MASER	—	microwave amplification by stimulated emission of radiation
MCS	—	modified channeled substrate (laser)
MDC	—	mirror dispersion controlled (oscillator)
MDR	—	morphology-dependent resonance (laser)
MIH	—	monolithically-integrated hybrid (laser)
MO	—	master oscillator
MOFPA	—	master oscillator-fiber power amplifier
MOPA	—	master oscillator power amplifier
MOPO	—	master oscillator power oscillator
MPL	—	microgun-pumped laser
MQB	—	multi-quantum barrier (laser)
MQW	—	multiple quantum well (laser)
MVL	—	metal vapor laser
NDFA	—	neodymium fiber amplifier
NDPL	—	nuclear device pumped laser
NPL	—	nuclear-pumped laser
OCL	—	optical confinement layer (laser)
OPA	—	optical parametric amplifier
OPAL	—	optical parametric amplifier laser
OPO	—	optical parametric oscillator
OPOL	—	optical parametric oscillator laser
OPPO	—	optical parametric power oscillator
OPS	—	optically pumped semiconductor (laser)
PBC	—	p-type buried crescent (laser)
PBC	—	planar buried crescent (laser)
PBH	—	planar burried heterostructure (laser)
PCSEL	—	planar cavity surface-emitting laser
PDFFA	—	praseodymium-doped fluoride fiber amplifier
PIL	—	photolylic iodine laser
PINSCH	—	periodic-index separate-confinement heterostructure (laser)

Appendix 1—*continued*

Abbreviations, Acronyms, Initialisms, and Common Names for Types and Structures of Lasers and Amplifiers

PLC	—	planar lightwave circuit (laser)
POFA	—	polymer optical fiber amplifier
POWA	—	planar optical waveguide amplifier
PRFA	—	praseodymium fiber amplifier
QB	—	quantum box (laser)
QC	—	quantum cascade (laser)
QCL	—	quantum cascade laser
QD	—	quantum dot (laser)
QF	—	quantum film (laser)
QW	—	quantum well (laser)
QW	—	quantum wire (laser)
QWH	—	quantum well heterostructure (laser)
QWR	—	quantum well ridge (laser)
QWS	—	quantum well structure (laser)
RFA	—	Raman fiber amplifier
RGH	—	rare gas halide (laser)
RPL	—	reactor pumped laser
RS	—	Raman-shifted (laser)
RW	—	ridge waveguide (laser)
SASE	—	self-amplified spontaneous emission
SB-BGSL	—	strain-balanced BGSL (laser structure)
SBL	—	space based laser
SBS	—	stimulated Brillouin scattering (amplifier)
SCBH	—	separate confinement buried heterostructure (laser)
SCH	—	separate carrier heterostructure (laser)
SCH	—	separate confinement heterostructure (laser)
SCL	—	semiconductor laser
SCLA	—	semiconductor laser amplifier
SDL	—	semiconductor diode laser
SE	—	surface-emitting (laser)
SEL	—	surface-emitting laser
SELD	—	surface-emitting laser diode
SELDA	—	surface-emitting laser diode array
SIPBH	—	semi-insulating planar buried heterostructure (laser)
SL	—	superlattice (laser structure)
SLA	—	semiconductor laser amplifier
SL-MQW	—	strained-layer multiple quantum well (laser)

Appendix 1—*continued*

Abbreviations, Acronyms, Initialisms, and Common Names for Types and Structures of Lasers and Amplifiers

SLS	—	strained-layer superlattice (laser structure)
SM	—	submillimeter (laser)
SOA	—	semiconductor optical amplifier
SP-APM	—	stretched-pulse additive pulse mode-locked (laser)
SPL	—	short pulse laser
SPML	—	synchronously-pumped mode-locked (laser)
SPPO	—	synchronously pumped parametric oscillator
SQW	—	single quantum well (laser)
SRS	—	stimulated Raman scattering (amplifier)
SSL	—	serpentine superlattice (laser structure)
SSQW	—	strained single quantum well laser
SXR	—	soft x-ray (laser)
T2QWL	—	type II quantum well laser
T^3	—	tabletop-terawatt (laser)
TAL	—	thin active layer (laser)
TAPS	—	tapered stripe (laser)
TCL	—	taper coupled laser
TCSM	—	twin-channel substrate mesa (laser)
T-cubed	—	tabletop terawatt (laser)
TDL	—	tunable diode laser
TEA	—	tranverse excited atmospheric pressure (laser)
TFR	—	tightly folded resonator (laser)
TIE	—	tunable interdigital electrode (DBR laser)
TJS	—	transverse junction stripe (laser)
TRS	—	twin-ridge structure (laser)
TTW-SLA	—	traveling wave semiconductor laser amplifier
UCL	—	upconversion laser
VCSEL	—	vertical cavity surface-emitting laser
VECOD	—	vertical-coupled quantum dot (laser)
VLD	—	visible laser diode
VSIS	—	V-channeled substrate inner stripe (laser)
VSQW	—	variable-strained quantum well (laser)
WDM	—	wavelength-division multiplexing
WGM	—	whispering galley mode (laser)
YAG	—	yttrium aluminum garnet (laser host crystal)
YDFA	—	ytterbium-doped fiber amplfier
YLF	—	yttrium lithium fluoride (laser host crystal)

Appendix 1—*continued*

Abbreviations, Acronyms, Initialisms, and Common Names for Types and Structures of Lasers and Amplifiers

YVO	—	yttrium vanadate (laser host crystal)
Z-laser	—	zone laser (self-focusing)

APPENDIX 2

Abbreviations, Acronyms, Initialisms, and Mineralogical or Common Names for Solid State Laser Materials*

alexandrite	—	chromium-doped chryoberyl ($BeAl_2O_4$)
BEL	—	lanthanum beryllate ($La_2Be_2O_5$)
BLGO	—	barium lanthanum gallate ($BaLaGa_3O_7$)
BYF	—	barium yttrium fluoride (BaY_2F_8)
CNGG	—	calcium niobium gallium garnet ($Ca_3[NbLiGa]_5O_{12}$)
colquiriite	—	lithium calcium aluminum fluoride ($LiCaAlF_6$)
CTH:YAG	—	Cr,Tm,Ho:$Y_3Al_5O_{12}$
emerald	—	chromium-doped beryl ($Be_3Al_2Si_6O_{18}$)
FAP	—	calcium fluoroapatite ($Ca_5[PO_4]_3F$)
forsterite	—	magnesium silicate (Mg_2SiO_4)
GGG	—	gadolinium gallium garnet ($Gd_3Ga_5O_{12}$)
GSGG	—	gadolinium scandium gallium garnet ($Gd_3Sc_2Ga_3O_{12}$)
HAP	—	high-average-power (laser glass)
LiCAF	—	lithium calcium aluminum fluoride ($LiCaAlF_6$)
LiSAF	—	lithium scandium aluminum fluoride ($LiScAlF_6$)
LMA	—	lanthanum magnesium hexaluminate ($LaMgAl_{11}O_{19}$)
LSB	—	lanthanum scandium borate [$LaSc_3(BO_3)_4$]
NYAB	—	neodymiun yttrium aluminum borate $Nd_xY_{1-x}Al_3(BO_3)_4$
ruby	—	Cr-doped aluminum oxide (Al_2O_3)
S–FAP	—	strontium fluoroapatite [$Sr_5(PO_4)_3F$]
silica	—	silicon dioxide (amorphous)
S–VAP	—	strontium vanadium fluoroapatite [$Sr_5(VO_4)_3F$]
Ti:sapphire	—	titanium-doped aluminum oxide (Al_2O_3)
YAB	—	yttrium aluminum borate [$YAl_3(BO_3)_4$]
YAG	—	yttrium aluminum garnet ($Y_3Al_5O_{12}$)
YALO	—	yttrium aluminate ($YAlO_3$)
YAP	—	yttrium aluminum perovskite ($YAlO_3$)
YBF	—	yttrium barium fluoride (Y_2BaF_8)
YGG	—	yttrium gallium garnet ($Y_3Ga_5O_{12}$)
YLF	—	yttrium lithium fluoride ($LiYF_4$)
YSAG	—	yttrium scandium aluminum ($Y_3Sc_2Al_3O_{12}$)
YSGG	—	yttrium scandium gallium ($Y_3Sc_2Ga_3O_{12}$)
YSO	—	yttrium silicon oxide, yttrium orthosilicate (Y_2SiO_5)
YVO	—	yttrium vanadate (YVO_4)
ZBLAN	—	Zr-Ba-La-Al-Na fluorozirconate glass

* For a more complete listing of abbreviations, acronyms, initialisms, and mineralogical or common names for laser materials, see Appendix 2 of the *Handbook of Laser Science and Technology: Supplement 2 – Optical Materials*, CRC Press, Boca Raton (1995).

APPENDIX 3

Fundamental Physical Constants

Quantity	Symbol	Value
speed of light in vacuum	c	299 792 458 m/s
permeability of vacuum	μ_0	$1.256\ 637\ 061\ 4 \times 10^{-6}$ N/A^2
permittivity of vacuum, $1/\mu_0 c^2$	ε_0	$8.854\ 187\ 817 \times 10^{-12}$ F/m
Planck constant	h	$6.626\ 075\ 5 \times 10^{-34}$ J s
elementary charge	e	$1.602\ 177\ 33 \times 10^{-19}$ C
magnetic flux quantum, h/2e	Φ_0	$2.067\ 834\ 61 \times 10^{-15}$ Wb
electron mass	m_e	$9.109\ 389\ 7 \times 10^{-31}$ kg
proton mass	m_p	$1.672\ 623\ 1 \times 10^{-27}$ kg
fine structure constant	α	$7.297\ 353\ 08 \times 10^{-3}$
inverse fine-structure constant	$1/\alpha$	137.035 989 5
Rydberg constant, $m_e c\alpha^2/2h$	R_∞	10 973 731.534 m^{-1}
Bohr radius, $\alpha/4\pi R_\infty$	a_0	$0.529\ 177\ 249 \times 10^{-10}$ m
Hartree energy, $e^2/(4\pi\varepsilon_0)a_0 = 2R_\infty hc$	E_h	$4.359\ 748\ 2 \times 10^{-18}$ J
Compton wavelength, $h/m_e c$	λ_C	$2.426\ 310\ 58 \times 10^{-12}$ m
classical electron radius, $\alpha^2 a_0$	r_e	$2.817\ 940\ 92 \times 10^{-15}$ m
Bohr magneton, $eh/4\pi m_e$	μ_B	$9.274\ 015\ 4 \times 10^{-24}$ J/T
nuclear magneton, $eh/4\pi m_p$	μ_N	$5.050\ 786\ 6 \times 10^{-27}$ J/T
electron magnetic moment	μ_e	$9.284\ 770\ 1 \times 10^{-24}$ J/T
magnetic moment anomaly, $\mu_{e/}\ \mu_B - 1$	a_e	$1.159\ 653\ 193 \times 10^{-3}$
electron g factor, $2(1 - a_e)$	g_μ	2.002 319 304 386
proton gyromagnetic ratio	γ_p	$2.675\ 221\ 28 \times 10^8$ s^{-1}T^{-1}
Avogadro constant	N_A	$6.022\ 136\ 7 \times 10^{23}$ mol^{-1}
Boltzmann constant, R/N_A	k	$1.380\ 658 \times 10^{-23}$ J/K
Faraday constant, $N_A e$	F	96 485.309 C/mol
molar gas constant	R	8.314 510 J/mol K
Stefan-Boltzmann constant	s	$5.670\ 51 \times 10^{-8}$ W/m^2 K^4

References:

Cohen, E. R. and Taylor, B. N., The 1986 adjustment of the fundamental physical constants, *Rev. Mod. Phys.* 59, 1121 (1987).

Taylor, B. N. and Cohen, E. R., Recommended values of the fundamental physical constants: a status report, *J. Res. Natl. Inst. Stand. Technol.* 95, 497 (1990).

CONVERSION FACTORS

Energy E (joule)	Frequency ν (hertz)	Wavelength λ (nanometer)	Wavenumber σ (centimeter)$^{-1}$	Electron volt eV (volt)	Temperature T (kelvin)
E	$E = h\nu$	$E = hc/\lambda$	$E = hc\sigma$	$E = 10^8$ eV/c	$E = kT$
1 J	1.5092×10^{33}	1.9864×10^{-16}	5.0341×10^{22}	6.2415×10^{18}	7.2429×10^{22}
6.6261×10^{-34}	1 Hz	2.9979×10^{17}	3.3356×10^{-11}	4.1357×10^{-15}	4.7992×10^{-11}
1.9864×10^{-16}	$2,9979 \times 10^{17}$	1 nm	10^7	1239.8	1.4388×10^7
1.9864×10^{-23}	2.9979×10^{10}	10^7	1 cm^{-1}	1.2398×10^{-4}	1.4388
1.6022×10^{-19}	2.4180×10^{14}	1239.8	8065.5	1 eV	11,604
1.3807×10^{-23}	2.0837×10^{10}	1.4388×10^{y}	0.69504	8.6174×10^{-5}	1 K

NOTE: The unit at the top of a column applies to all values below; all values on the same line of the table are equal.

Other conversions:

1 cm^{-1} = 1 kayser = 10^4 angstrom (Å) = 1.331×10^{-13} atomic mass unit = 2.426×10^{-10} electron mass unit

1 cm^{-1} ≈ 1.44 K ≈ 30 GHz ≈ 1.24×10^{-4} eV ≈ 2×10^{-16} erg ≈ 10^4 tesla (g = 2)

1 hartree = 27.2116 eV = 4.35975×10^{-18} joule

1 bohr = 0.52918 angstrom (Å)