

Appendix A

Laser Safety

Hazards associated with solid-state lasers can be separated into two broad categories: those hazards related to the laser beam itself and those hazards related to the electronic equipment.

Radiation Hazards

Although high-power solid-state lasers have the capability of inflicting burns on the skin, the possibility of eye injury is immensely important. The property of lasers that is of primary concern with regard to eye hazards is their high radiance, i.e. the combination of high power density and directionality. The latter property causes the eye lens to focus the parallel beam emitted from a laser to a tiny spot on the retina. It also makes the laser hazardous over long distances.

Figure A.1 shows a cross section of the human eye. The figure shows a collimated beam of visible light impinging onto the cornea, being focused by the eye lens, passing through the aqueous humor, and impinging onto the retina. At the retina the light is absorbed. Under normal conditions the photon energy is converted by the retina into chemical energy, stimulating optical sensations.

Figure A.1 illustrates the principal reason for possible eye injury from a laser. The parallel rays of a laser can be focused through the eye lens to a point image of about 10–20 μm in diameter. If the pupil is dilated sufficiently to admit the entire beam of a laser, even lasers having power outputs of only a few milliwatts will produce power densities of kilowatts per square centimeter on the retina. Obviously, power densities of this magnitude may cause severe damage to the retina. For worst-case conditions—the eye focused at infinity and the pupil fully dilated (about 0.7 cm diameter)—the ratio of power density at the eye lens to that at the retina will be about 10^5 .

By comparison, conventional sources of illumination are extended, they are considerably less bright, and they emit light in all directions. These light sources produce a sizable image on the retina with a corresponding lower power density. For example, looking directly into the sun, the image of it on the retina is approximately 160 μm in diameter which yields a radiation intensity of around $30\text{W}/\text{cm}^2$.

The maximum permissible exposure of laser radiation to the eye depends on the wavelength and is dependent on the spectral transmission of the eye. Figure A.2. illustrates the spectral transmission characteristics of the human eye [A.1]. Retinal damage is possible from exposure to laser energy in the wavelength region between 400 and

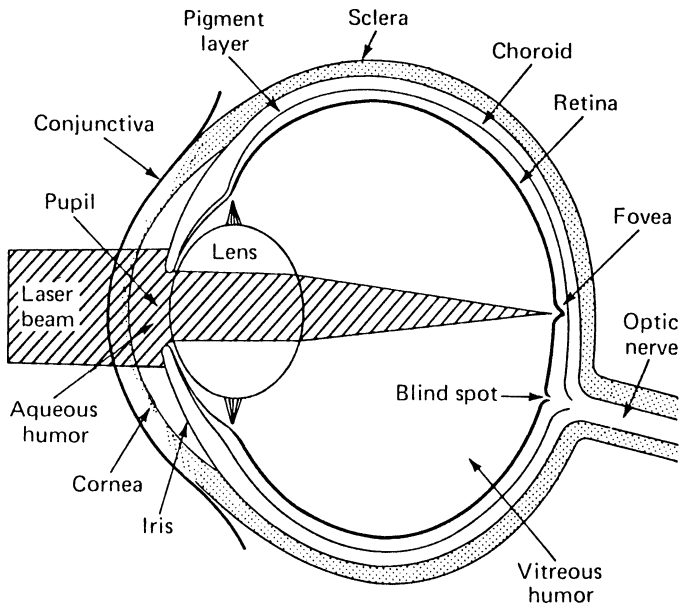


Fig. A.1. Cross section of the human eye

1400 nm (Fig. A.2c). In particular, radiation between 400 and 700 nm represents the greatest hazard, because the transmission of the anterior parts of the eye (cornea, aqueous humor, lens) is highest for this spectral region. At wavelengths longer than 700 nm, there is some absorption of the radiation before it reaches the retina. At IR

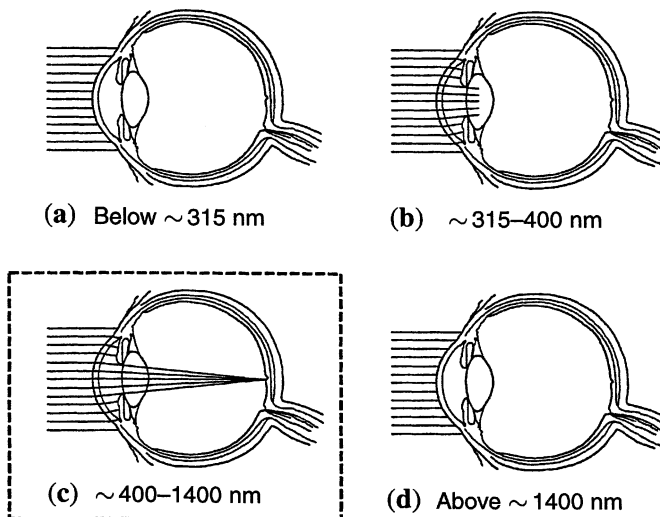


Fig. A.2. Spectral transmission characteristics of the human eye [A.1]

wavelengths greater than 1.4 μm , absorption of incident radiation occurs in the cornea and aqueous humor, and at wavelengths beyond 1.9 μm , absorption is restricted to the cornea alone (Fig. A.2d). Also ultraviolet radiation with a wavelength shorter than 315 nm is completely absorbed by the cornea (Fig. A.2a). Between 315 and 400 nm, radiation is absorbed at the lens of the eye (Fig. A.2b).

Electrical Hazards

Although the hazards of laser radiation are receiving deserved attention from government agencies, users, and manufacturers, the chief hazard of flashlamp pumped solid-state lasers is electrical rather than optical. Many solid-state lasers require high-voltage power supplies and energy-storage capacitors charged to lethal voltages. Furthermore, associated equipment such as Q-switches, optical gates, modulators, etc., are operated at high voltages. The power supply and associated electrical equipment of a laser can produce serious shock and burns and, in extreme cases, can lead to electrocution.

Safety Precautions Applicable to Solid-State Lasers

Enclosure of the beam and target in an opaque housing is the safest way of operating a laser. This level of safety precaution is mandatory for laser materials-processing systems operated in an industrial environment. In these systems interlocked doors, warning signs and lights, key-locked power switches, and emergency circuit breakers, and similar precautions are taken to protect operators and passers-by from electrical and radiation hazards of the laser equipment. Also, microscopes and viewing ports are filtered or blocked to prevent the issuance of laser radiation, and laser impact points are surrounded by shields. At points of access for routine maintenance and set-up, warning signs are displayed prominently, and interlocks prevent firing of the laser while doors or ports are open.

In the laboratory it is often not possible to completely enclose a high-power laser. In these situations the following safety precautions should be observed:

- Wear laser safety glasses at all times! Make sure that their attenuation factor is sufficient at the wavelengths present.
- Never look directly into the laser light source or at scattered laser light from any reflective surface. Never sight down the beam into the source.
- Set up the laser and all optical components used with it below eye level. Provide enclosures for the beam. Do not direct the beam outside the table on which the laser is positioned without using protective tubing.
- The output from Nd lasers and other IR lasers is invisible to the human eye. Use a IR viewing scope to check for specular reflected beams.
- Avoid operating the laser in a darkened environment. At low light levels the size of the iris is large and can hence accept a large amount of light. Work under as bright light conditions as possible (small iris).

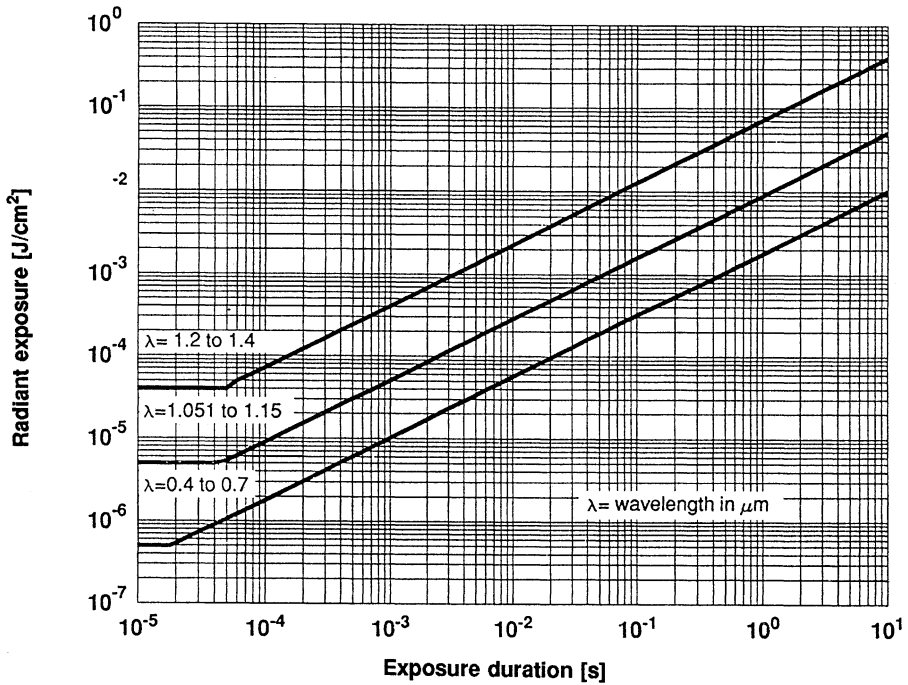


Fig. A.3. Exposure limits for direct viewing of a laser beam as a function of pulse width. Ranges are for visible and near-infrared spectral regions [A.2]

- Employ a countdown or other audible warning before the laser is fired.
- Post the appropriate hazard warning signs as specified in ANSI Z136.1 (1993) at the entrance to the laboratory.
- Control access to the laser area and have a flashing red light on the door when the laser is in operation. Operation of very large laser systems, such as used in inertial confinement fusion experiments, actually require the installation of safety interlocks at the entrance of the laser facility to prevent entry of unauthorized personnel into the facility while the laser power supply is charged and capable of firing the laser.
- Provide protection against accidentally contacting charged-up capacitors in energy-storage banks, high-voltage power supplies, etc. These components should be installed in cabinets having interlocked doors. Furthermore, capacitor banks should be equipped with gravity-operated dump solenoids.

The key to a successful safety program is the training and familiarization of the personnel involved with laser hazards and subsequent control measures. The appointment of a Laser Safety Officer is essential for companies or laboratories engaged in the manufacture or use of class III and class IV laser systems.

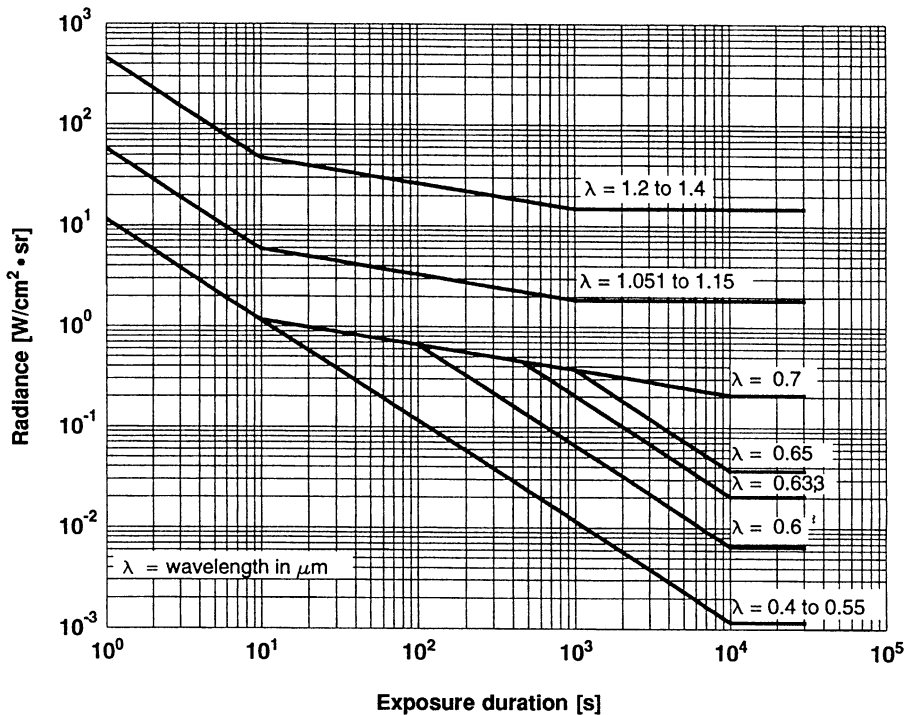


Fig. A.4. Exposure limits for direct viewing of a cw laser beam [A.2]

Laser Safety Standards

The potential of lasers for inflicting injury, particularly to the eyes, was recognised early, and as a consequence extensive studies have been undertaken into the biological mechanisms of laser damage, in an attempt to define safe working levels of optical radiation.

A document which is very useful as a guide for the safe use of lasers and systems is the standard published by the American National Standards Institute [A.2]. A comprehensive reference work covering every aspect of safety with lasers and other optical sources is the handbook written by D. Sliney et al. [A.3]. Additional information on laser safety can be found in [A.4].

In the United States, regulations for manufacturers are published by the Center for Devices and Radiological Health (formerly Bureau of Radiological Health), under the Food and Drug Administration [A.5]. User requirements in the United States are the responsibility of the individual states, but only a few states have such laws.

Under the federal safety standard, four classes of lasers have been created to allow manufacturers to categorize a product based on its potential hazard to a user. These classes are labeled I through IV, from the most safe to the most hazardous. Class I and II are used for lasers of cw outputs of less than $0.39 \mu\text{W}$ and 1 mW , respectively. Class III

and IV include lasers which represent a definite hazard to the eye from direct or scattered radiation. Solid-state lasers generally fall into class III or IV of that standard, which requires that warning signs, labels, and protective housings be installed to prevent human irradiation at levels in excess of a “safe” limit. Safety interlocks must be provided for each portion of the protective housing that can be removed by the user during normal operation or maintenance. In the event that the design of the safety interlock allows the user to defeat the system manually, the manufacturer must incorporate visible or audible warnings of this interlock override during laser operation. In addition, key-lock switches and warning lights are required along with other safety devices. Outside the United States, most countries have adopted the ANSI standard, or a similar standard generated by the International Electrotechnical Commission [A.6].

The author found the information presented in Figs. A.3 and A.4 quite useful in calculating the safe distance at which accidental direct viewing of the laser beam does not present a hazard. These situations occur quite frequently in field tests involving rangefinders, LIDAR's and similar equipment. Figure A.3 provides the occupational health and safety limits for pulsed laser radiation in the visible and near infrared spectrum. The curves show the safe fluence limits vs. pulsewidth for the visible and NIR. Compared to the visible regime, the threshold for eye damage is higher in the NIR because the focused spot on the retina is larger, furthermore higher transmission losses are encountered for the longer wavelength. The increase in fluence level with longer pulses reflects the fact that heat produced at the retina can be more effectively dissipated to the surrounding tissue as the exposure time increases. For exposure times shorter than about 50 μs , heat dissipation is insignificant and the damage threshold does not depend on pulsewidth. For exposure levels 10 times as high as indicated in Fig. A.3, there is a 50% probability of the occurrence of ophthalmologically visible retinal lesions [A.3].

Figure [A.4] gives the exposure limits for direct viewing of a cw laser beam for wavelengths ranging from 0.4 to 1.4 μm . The damage threshold for the longer wavelengths is higher for the same reasons as stated above. The reader is reminded that the data presented in these figures should only be considered as guidelines.

Appendix B

Conversion Factors and Constants

In this appendix we have listed some of the most frequently used conversion factors, constants, and definitions.

Physical Constants

h	$= 6.626 \times 10^{-34} \text{ J s}$	Planck constant
e	$= 1.602 \times 10^{-19} \text{ A s}$	Charge of an electron
k	$= 1.381 \times 10^{-23} \text{ J K}^{-1}$	Boltzmann constant
c	$= 2.998 \times 10^8 \text{ m s}^{-1}$	Speed of light in vacuum
ϵ_0	$= 8.854 \times 10^{-12} \text{ A s V}^{-1} \text{ m}^{-1}$	Permittivity of free space
μ_0	$= 1.257 \times 10^{-6} \text{ V s A}^{-1} \text{ m}^{-1}$	Permeability of free space
Z_0	$= \sqrt{\mu_0/\epsilon_0} = 376.7 \Omega$	Impedance of free space
g	$= 9.81 \text{ m s}^{-2}$	Acceleration due to gravity

Force Conversions

1 dyne	$= 1 \text{ g cm s}^{-2}$
1 N	$= 1 \text{ kg m s}^{-2} = 10^5 \text{ dyne}$
1 kp	$= 9.81 \text{ kg m s}^{-2}$

Energy Conversions

1 J	$= 1 \text{ W s}$
1 cal	$= 4.19 \text{ J}$
1 eV	$= 1.60 \times 10^{-19} \text{ J}$
1 erg	$= 10^{-7} \text{ J}$

Pressure Conversions

1 Pa	$= 1 \text{ N m}^{-2}$
1 atm	$= 1.013 \text{ bar} = 1.033 \text{ kp cm}^{-2}$
1 bar	$= 10^6 \text{ dyne cm}^{-2} = 10^5 \text{ N m}^{-2}$
1 torr	$= 133.3 \text{ N m}^{-2}$
1 Pa	$= 9.87 \times 10^{-6} \text{ atm} = 145.1 \times 10^{-6} \text{ psi}$

Conversion of English Units into the MKS System

1 inch	= 2.540 cm
1 gal	= 3.785 l
1 lbs	= 0.453 kg
1 atm	= 14.7 psi
1 Btu	= 1055.8 W s
$T [^{\circ}\text{C}]$	= $\frac{5}{9}(T [^{\circ}\text{F}] - 32)$
$\Delta T [^{\circ}\text{C}]$	= $\frac{5}{9}\Delta T [^{\circ}\text{F}]$
$1 \text{ cal cm}^{-1} \text{ C}^{-1} \text{ s}^{-1}$	= 242 Btu/hr ft F
1 cal g^{-1}	= 1.8 Btu/lb

Conversion of Angles

$$1^{\circ} = 17.45 \text{ mrad}; 1' = 0.29 \text{ mrad}; 1'' = 4.85 \mu\text{rad}$$

$$1 \text{ rad} = 57^{\circ} 17' 45'', 1 \text{ mrad} = 3' 26''$$

Conversion of Wavenumber $n [\text{cm}^{-1}]$ to Energy

$$E = n \text{ hc}$$

$$\text{hc} = 1.986 \times 10^{-23} \text{ W s cm}$$

Conversion of Linewidth Given in Wavelength ($\Delta\lambda$) or Wavenumber (Δn) to Bandwidth ($\Delta\nu$)

$$\Delta\nu/\nu = \Delta\lambda/\lambda = \Delta n/n$$

$$\Delta\nu = c \Delta n$$

$$\Delta\lambda = \Delta n \lambda^2 = \Delta\nu \lambda^2/c$$

Amplifier Gain

$$g(\text{dB}) = 10 \log(E_2/E_1)$$

Optical Units

Wave number	$n [1/\text{cm}] = 10^4/(\lambda [\mu\text{m}])$
Frequency	$\nu [\text{Hz}] = 3 \times 10^{14}/(\lambda [\mu\text{m}])$
Photon energy	$E [\text{J}] = 1.987 \times 10^{-19}/(\lambda [\mu\text{m}])$
Photon energy	$E [\text{eV}] = 1.24/(\lambda [\mu\text{m}])$

Conversion of Transmission T to Optical Density D

$$T = 10^{-D}$$

Conversion of Units for the Nonlinear Index of Refraction n_2

$$n_2[\text{esu}] = 238.6 n_0 n_2 [\text{cm}^2/\text{W}]$$

$$n_2[\text{cm}^2/\text{W}] = 4.19 \times 10^{-3} (n_2/n_0) [\text{esu}]$$

Conversion of Beam Quality Factor M to Beam Diameter-Divergence Product $D\Theta$

$$M^2 = D\Theta / (4\lambda/\pi)$$

D = beam diameter (mm)

Θ = full beam angle (mr)

λ = wavelength (mm)

M = beam quality factor

Diffraction Limited Beam (TEM_{00} Mode)

$$M^2 = 1$$

$$\Theta_0 D_0 = 4\lambda/\pi$$

$D_0 = 2w_0$, diameter of beam waist ($1/e^2$ points)

$$\Theta_0 D_0 = 1.35 \text{ mm mr at } 1.064 \mu\text{m}$$

Appendix C

Definition of Symbols

A_{21}	Einstein coefficient (Chap. 1)
A^*	area
a	aperture radius
b	confocal parameter
B_{21}, B_{12}	Einstein coefficients (Chap. 1)
B	beam breakup integral (Chap. 4)
B_r	brightness (Chap. 4)
c, c_0	speed of light
c_p	specific heat (Chap. 7)
C	capacitance (Chap. 6)
C_T, C_r, C_ϕ, C_B	combination of material constants (Chap. 7)
d	thickness (Chaps. 5 and 9)
$d, d_{14}, d_{\text{eff}}$	coefficient of nonlinear polarization
D, D_0	beam diameter
e	electron charge
E	Young's modulus (Chap. 7)
E_1, E_2, E_3, E_0	energy levels (Chap. 1)
E_{st}	stored energy
ΔE	energy difference
E_{EL}	electrical input energy
E_{SC}	scale factor energy (Chap. 8)
$E_{\text{in}}, E_{\text{out}}, E_{\text{opt}}$	input, output, and optical energy (Chaps. 3 and 4)
E_{ex}	flashlamp explosion energy
E_i, E_0, E_s	input, output, and saturation fluence
E_1, E_2, E_3, E	electric field strength (Chap. 10)
E_j, E_z	electric field strength (Chap. 8)
$f, f', f'', f_x, f_y, f_{\text{ef}}$	focal length
F	fineness of interferometer (Chap. 5)
f	pulse repetition rate (Chap. 8)
$g_1, g_2, g(n_1), g(R_1), g(R_2)$	degeneracy of energy levels (Chaps. 1–3)
$g(v, v_0), g(v_0), g(v), g(v_s, v_0)$	atomic lineshape function (Chaps. 1 and 3)
g_0, g	gain coefficient

*Symbols whose definitions are not followed by chapter numbers are used throughout the book.

G, G_0	gain
g, g_1, g_2	parameters of resonator stability (Chaps. 5 and 9)
$h\nu$	photon energy
h	surface heat transfer coefficient (Chap. 7)
h	Planck constant (Chap. 6)
$I, I_L, I_R, I_{\text{circ}}, I_{\text{out}}, I_{\text{IN}}, I_P, I_0$	power density of laser beam
I_{av}, I_w	power density of pump radiation (Chap. 3)
I_{ASE}	fluorescence flux (Chap. 4)
$I_{\text{mn}}, I_{\text{pl}}$	intensity distribution of radial modes
I_{ac}	acoustic power density (Chap. 8)
I_S	saturation power density
i, i_P, i_S	current
$J_{\text{ST}}, J_{\text{th}}$	energy density (Chaps. 2 and 4)
K_0	flashlamp parameter (Chap. 6)
K	thermal conductivity
kT	thermal energy
k	diffusivity (Chap. 7)
K, K'	nonlinear coupling factor (Chap. 10)
K_1, K_2, K_3	combination of parameters (Chap. 10)
$k_p, k_s, k_i, k_w, k_{2w}, \Delta k$	wave number
$l, l(r), l_0$	length of active medium
Δl	pathlength difference (Chap. 7)
L, L_0, L_1, L_2	distances within resonator
l_C, l_a	coherence and aperture length
L	inductance (Chap. 6)
l, m, n, p	higher order modes (Chap. 5)
M	beam quality figure of merit (Chap. 5)
M	power ratio (Chap. 10)
m	magnification of unstable resonator (Chap. 5)
m	mass flow rate (Chap. 7)
M_{ac}	acoustic figure of merit (Chap. 8)
M_r, M_ϕ	thermal lensing sensitivity (Chap. 7)
$n_0, n_S, n_i, n_p, n_x, n_y$	refractive index
$\Delta n_0, \Delta n(r), \Delta n_\phi, \Delta n_r$	refractive index difference
$n_{1\omega}, n_{2\omega}, n_{3\omega}$	index at harmonic frequencies
n^0, n^e	ordinary and extraordinary refractive index
$n(r), n_r, n_\phi$	index in radial and tangential direction
dn/dT	temperature dependence of index
$dn/d\lambda$	wavelength dependence of index
$n(I)$	intensity dependence of index
n_2	nonlinear refractive index (Chaps. 4 and 9)
n_g, n_1	ground state and lower laser level population density
n_2, n	upper laser level population density
n_{tot}	total population density
$n_i, n_t, n_f, n_{\text{oo}}$	initial, threshold, final, and steady-state population density

Δn	perturbation of population density (Chap. 3)
$N_1, N_2, N_0, N_{\text{tot}}, N(\nu), \Delta N$	population of energy levels
N, N_{eq}	Fresnel number (Chap. 5)
N	number of axial modes (Chap. 9)
N	number of flashlamp firings (Chap. 6)
N_{ph}	number of photons (Chap. 5)
N	number density of molecules (Chap. 10)
$P_{\text{in}}, P_{\text{out}}, P_{\text{th}}, P, P_{\text{opt}}$	Input, output, threshold, intracavity, and optimum power
$P_{\text{av}}, P_{\text{p}}, P_{\text{cw}}$	average, peak, and cw power
$P_{\omega}, P_{2\omega}$	fundamental and harmonic power
P_{ac}	acoustic power (Chap. 8)
$P_{\text{a}}, P_{\text{h}}$	absorbed and dissipated power
$P_{\text{cr}}, P_{\text{f}}, P_{\lambda}$	critical, fluorescence, and spectral power
$P_{\text{avail}}, P_{\text{e}}$	available and incident power
$p_{\text{iklm}}, p_{\text{ij}}$	photoelastic tensor, coefficients
P	induced polarization (Chap. 10)
p	gas pressure (Chap. 6)
$p, p_{\text{n}}, p_{\text{L}}$	resonator modes (Chaps. 1 and 5)
Q	resonator quality factor (Chap. 3)
Q	heat per volume (Chap. 7)
q	parameter (Chap. 7)
$R_1, R_2, R, R_{\text{opt}}, R_{\text{th}}, R'$	reflectivity
$r, r_0, r_{\text{L}}, r_{\text{R}}$	radius
$R(z), R_1, R_2, R, R_{\text{eff}}$	radius of curvature of resonator mirrors (Chap. 5)
R_{d}	electrical resistance (Chap. 6)
r_{ij}	electro-optic coefficients
R_{S}	thermal shock parameter (Chap. 7)
r_{p}	pump intensity distribution
$R(\lambda, T)$	flashlamp radiation
s	strain (Chap. 8)
s	Kerr lens sensitivity (Chap. 9)
S, S_1, S_2, S_0	combination of material constants (Chap. 7)
$T, T_{\text{opt}}, T_{\text{n}}, T_{\text{o}}, T_{\text{i}}, T_{\text{max}}$	transmission
$t_{\text{p}}, t_{\text{R}}$	pulse width, rise time
$T, T(r), T(r_0), T(o), T_{\text{F}}$	temperature
t	time
t_{r}	round trip time of photons
t_{LC}	time constant
u	nonlinear loss coefficient
V	volume (Chaps. 3 and 8)
$V, V_0, V_{\text{z}}, V_{1/2}$	voltage (Chaps. 6 and 8)
$v, v_{\text{s}}, v_{\text{g}}$	velocity
W	blackbody radiation (Chap. 1)
w	width
W_{p}	pump rate

W_{13}, W_{03}	pump parameter (Chap. 1)
W_{av}, W_s	energy density (Chap. 3)
$w_0, w, w_1, w_2, w_p, w_{pl},$ w_m, w_n	beam radius
x, y, z	distance
Z_0, Z	impedance
z	parameter
$\alpha_0, \alpha_0(\nu_s), \alpha_0(E)$	absorption coefficient
α	damping factor of current pulse (Chap. 6)
α	pulse shape factor (Chap. 9)
α	thermal expansion coefficient (Chap. 7)
α_p	angle (Chaps. 6 and 9)
β_0	propagation constant (Chap. 8)
β	combination of parameters (Chap. 4)
β_θ	angular sensitivity of doubling crystal (Chap. 10)
β	frequency chirp (Chap. 9)
β''	group dispersion in solids (Chap. 9)
χ	susceptibility (Chap. 10)
χ	heat deposition (Chap. 7)
$\delta, \delta_m, \delta_0, \delta_{depol}$	resonator losses
δ_{AM}, δ_{FM}	modulation depth
$\Delta_q, \Delta(2p + l), \Delta(m + n)$	frequency separation of axial modes (Chap. 5)
$\varepsilon(\lambda, T)$	emissivity (Chap. 6)
ε	resonator losses including output coupling (Chaps. 3 and 8)
$\varepsilon_0, \varepsilon$	permittivity (Chap. 10)
$\phi, \phi_0, \phi(r), \phi(x, t)$	photon density
ϕ	polar coordinate, azimuth angle
γ	factor determining three- or four-level laser
γ	nonlinear refractive coefficient (Chaps. 4 and 9)
γ	electrostrictive coefficient (Chap. 10)
η_Q, η_S, η_d	quantum, quantum defect, and differential quantum efficiency
$\eta_P, \eta_a, \eta_{sys}$	pump, absorption, and system efficiency
η_c, η_B, η_E	coupling, overlap, and extraction efficiency
$\eta_{St}, \eta_{ASE}, \eta_{EQ}$	Q-switch efficiencies
η_h	fractional heat load (Chap. 7)
$\eta_{amp}, \eta_{par}, \eta_{Ram}$	amplifier, parametric, and Raman efficiency
η, η'	combination of efficiency factors
$\varphi, \Delta\varphi, d\varphi, \varphi(t)$	phase angle
κ	combination of constants (Chap. 10)
κ	Boltzmann factor (Chap. 2)
$\lambda, \lambda_0, \lambda_1, \lambda_2, \lambda_p, \lambda_s, \lambda_i, \lambda_L$	wavelength
$\Delta\lambda$	wavelength difference
Λ	periodicity of grating (Chap. 10)
μ	factor determining Bragg deflection (Chap. 9)

μ_0	permeability of free space
ν	Poisson's ratio (Chap. 7)
$\nu_0, \nu_s, \nu_p, \nu_L, \nu_i, \nu_R, \nu_m, \nu_{rf}$	frequency
$\Delta\nu, \Delta\nu_L, \Delta\nu_c, d\nu$	bandwidth, linewidth
$\theta, \theta_c, \theta_D, \theta', \theta_m, \Delta\theta$	angle
ρ	walk-off angle (Chap. 10)
ρ	normalized beam radius (Chap. 5)
ρ_0	mass density (Chaps. 7, 8 and 10)
$\rho(\nu)$	radiation density per unit frequency (Chap. 1)
σ	stimulated emission cross section
σ_s	slope efficiency of laser output versus input
$\sigma_r, \sigma_\phi, \sigma_z, \sigma_{\max}$	thermal stress (Chap. 7)
$\sigma_{12}, \sigma_{gs}, \sigma_{es}$	absorption cross section
σ	Stefan–Boltzmann constant (Chap. 1)
τ_f, τ_{21}	spontaneous emission lifetime of upper laser level
τ_c	decay time of photon density in resonator
τ_B	phonon lifetime (Chap. 10)
τ_R	decay time of relaxation oscillations (Chap. 3)
τ_{ij}	spontaneous emission lifetime between states E_i and E_j
$\omega, \omega_0, \omega_p, \omega_1, \omega_2, \omega_3, \omega_4, \omega_s$	frequency
$\Delta\omega$	bandwidth
Ω	solid angle beam divergence (Chap. 4)
$\zeta, \zeta_{\max}, \zeta(t, \phi)$	cavity losses (Chap. 8)

References

Chapter 1

- 1.1 A. Yariv: *Quantum Electronics*, 4th edn. (Wiley, New York 1991)
- 1.2 A.E. Siegman: *Lasers* (University Science Books, Mill Valley, CA 1986)
- 1.3 H. Haken: *Laser Theory* (Springer, Berlin Heidelberg 1984)
- 1.4 I.I. Sobelman: *Atomic Spectra and Radiative Transitions*, 2nd edn. Springer Ser. Atoms and Plasmas, Vol. 12 (Springer, Berlin Heidelberg)
- I.I. Sobelman, L.A. Vainshtein, E.A. Yukov: *Excitation of Atoms and Broadening of Spectral Lines*, 2nd edn. Springer Ser. Atoms and Plasmas, (Springer, Berlin Heidelberg, 1995)
- 1.5 H. Statz, G.A. de Mars: In *Quantum Electronics*, ed. by C.H. Townes (Columbia Univ. Press, New York, 1960) pp. 530–537

Chapter 2

- 2.1 S.E. Stokowski: In *Handbook of Laser Science and Technology*, ed. by M.J. Weber (CRC Press, Boca Raton, FL, 1982) pp. 215–264
- 2.2 P.F. Moulton: In *Handbook of Laser Science and Technology*, Vol. 1 ed. by M.J. Weber (CRC Press, Boca Raton, FL, 1986) pp. 21–295
- 2.3 L.G. DeShazer, S.C. Rund, B.A. Wechsler: In *Handbook of Laser Science and Technology*, Vol. 5, ed. by M.J. Weber (CRC Press, Boca Raton, FL, 1987) pp. 281–338
- 2.4 J.C. Walling: In *Tunable Lasers*, 2nd edn., ed. by L.F. Mollenauer, J.C. White, C.R. Pollock (Springer, Berlin, 1992) *Topics Appl. Phys.*, Vol. 59, Chap. 9
- 2.5 R.C. Powell: *Physics of Solid-State Laser Materials* (Springer, New York, 1998)
- 2.6 Special issue on solid-state lasers, IEEE J. Quantum Electron. **QE-24** (1988)
- 2.7 A.A. Kaminskii: *Crystalline Lasers* (CRC Press, Boca Raton, FL, 1996)
- 2.8 A.L. Schawlow, C.H. Townes: Phys. Rev. **112**, 1940 (1958)
- 2.9 T.H. Maiman: Nature **187**, 493 (1960)
- 2.10 J.E. Geusic, H.M. Marcos, L.G. Van Uitert: Appl. Phys. Lett. **4**, 182 (1964)
- 2.11 Kh.S. Bagdasarov, A.A. Kaminskii: JETP Lett. **9**, 303 (1969)
- 2.12 R. Wu, P.B. Phua, K.S. Lai: Appl. Opt. **39**, 431 (2000)
- 2.13 R.V. Alves, R.A. Buchanan, K.A. Wickersheim, E.A.C. Yates: J. Appl. Phys. **42**, 3043 (1971)
- 2.14 R.C. Ohlmann, K.B. Steinbruegge, R. Mazelsky: Appl. Opt. **7**, 905 (1968)
- 2.15 K.B. Steinbruegge, G.D. Baldwin: Appl. Phys. Lett. **25**, 220 (1974)
- 2.16 H.P. Weber, P.F. Liao, B.C. Tofield: IEEE J. Quantum Electron. **QE-10**, 563 (1974)
- 2.17 H.P. Weber, P.F. Liao, B.C. Tofield, P.M. Bridenbaugh: Appl. Phys. Lett. **26**, 692 (1975)
- 2.18 J.G. Gualtieri, T.R. Aucoin: Appl. Phys. Lett. **28**, 189 (1976)
- 2.19 H.G. Danielmeyer, G. Huber, W.W. Krühler, J.P. Jeser: Appl. Phys. **2**, 335 (1973)
- 2.20 V. Lupei, N. Pavel, Y. Sato, T. Taira: Opt. Lett. **28**, 2366 (2003)
- 2.21 J.R. O'Connor: Appl. Phys. Lett. **9**, 407 (1966)
- 2.22 T. Chin, R.C. Morris, O. Kafri, M. Long, D.F. Heller: In *High Power and Solid State Lasers*, SPIE Proc., Vol. 622, ed. By W.W. Simmons (SPIE, Bellingham, WA, 1986) p. 53

- 2.23 L.F. Johnson: J. Appl. Phys. **33**, 756 (1962); and **34**, 897 (1963)
- 2.24 P.P. Sorokin, M.J. Stevenson: Phys. Rev. Lett. **5**, 557 (1960); and in *Advances in Quantum Electronics*, ed. by J.R. Singer (Columbia Univ. Press, New York, 1961) p. 65
- 2.25 J. Lu, T. Murai, K. Takaichi, T. Uematsu, K. Misawa, M. Prabhu, J. Xu, K. Ueda, H. Yagi, T. Yanagitani, A.A. Kaminskii, A. Kudryashov: Appl. Phys. Lett. **78**, 3586 (2001)
- 2.26 I. Shoji, Y. Sato, S. Kurimura, V. Lupei, T. Taira, A. Ikeshue, K. Yoshida: Opt. Lett. **27**, 234 (2002)
- 2.27 Y. Feng, J. Lu, K. Takaichi, K. Ueda, H. Yagi, T. Yanagitani, A.A. Kaminskii: Appl. Opt. **43**, 2944 (2004)
- 2.28 N.P. Barnes, D.J. Gettemy: IEEE J. Quantum Electron. **QE-17**, 1303 (1981)
- 2.29 G.J. Quarles, A. Rosenbaum, C.L. Marquardt, L. Esterowitz: In *Solid State Lasers*, SPIE Proc., Vol. 1223, ed. by G. Dubé (SPIE, Bellingham, WA, 1990) p. 221
- 2.30 T.Y. Fan, G. Huber, R.L. Byer, Mitzscherlich: IEEE J. Quantum Electron. **QE-24**, 924 (1988)
- 2.31 N.P. Barnes, D.J. Gettemy, L. Esterowitz, R.A. Allen: IEEE J. Quantum **QE-23**, 1434 (1987)
- 2.32 T. Kushida, H.M. Marcos, J.E. Geusic: Phys. Rev. **167**, 289 (1968)
- 2.33 W.F. Krupke, M.D. Shinn, J.E. Marion, J.A. Caird, S.E. Stokowski: J. Opt. Soc. Am. B **3**, 102 (1986)
- 2.34 J.K. Neeland, V. Evtuhov: Phys. Rev. **156**, 244 (1967)
- 2.35 M. Birnbaum, J.A. Gelbwachs: J. Appl. Phys. **43**, 2335 (1972)
- 2.36 M.J. Weber, T.E. Varitimos: J. Appl. Phys. **42**, 4996 (1971)
- 2.37 S. Singh, R.G. Smith, L.G. Van Uitert: Phys. Rev. B **10**, 2566 (1974)
- 2.38 H.G. Danielmeyer, M. Blätte, P. Balmer: Appl. Phys. **1**, 269 (1973)
- 2.39 R.G. Smith: IEEE J. Quantum Electron. **QE-4**, 505 (1968)
- 2.40 S. Singh, R.G. Smith, L.G. Van Uitert: Phys. Rev. B **10**, 2566–2572 (1974)
- 2.41 A.A. Kaminskii: Sov. Phys. JETP **37**, 201 (1968)
- 2.42 J. Marling: IEEE J. Quantum Electron. **QE-14**, 56 (1978)
- 2.43 N. Barnes, B. Walsh, R. Davis: In *Advanced Solid-State Photonics, OSA Topical Mtg.*, San Antonio, TX, Feb 2003, Tech Digest, paper MB7-1
- 2.44 T.Y. Fan, R.L. Byer: IEEE J. Quantum Electron. **QE-23**, 605 (1987)
- 2.45 M. Birnbaum, C.F. Klein: J. Appl. Phys. **44**, 2928 (1973)
- 2.46 M.D. Thomas, G.A. Rines, E.P. Chicklis, W. Koechner: In *CLEO'86*, San Francisco, CA 1986, Paper WM4
- 2.47 Y. Inoue, S. Konno, T. Kojima, S. Fujikawa: IEEE J. Quantum Electron. **QE-35**, 1737 (1999)
- 2.48 Y. Inoe, S. Fujikawa: IEEE J. Quantum Electron. **36**, 751 (2000)
- 2.49 M.A. Kern, W.A. Clarkson, D.C. Hanna: In *Conf. on Lasers and Electro-Optics (CLEO)*, Washington, DC, 1997, Tech. Digest, paper CTuE4
- 2.50 M. Pierrou, F. Laurell, H. Karlsson, T. Kellner, C. Czeranowsky, G. Huber: Opt. Lett. **24**, 205 (1999)
- 2.51 V. Lupei, N. Pavel, T. Taira: Appl. Phys. Lett. **81**, 2677 (2002)
- 2.52 C. Czeranowsky, E. Heumann, G. Huber: Opt. Lett. **28**, 432 (2003)
- 2.53 S.M. Yarema, D. Milam: IEEE J. Quantum Electron. **QE-18**, 1941 (1982)
- 2.54 M.J. Weber: J. Non-Cryst. Solids **42**, 189 (1980)
- 2.55 S.E. Stokowski, R.A. Saroyan, M.J. Weber: Nd:doped laser glass spectroscopic and physical properties, Report M-095 (Rev.2) (Lawrence Livermore Nat'l Lab, 1981)
- 2.56 M.J. Weber, D. Milam, W.L. Smith: Opt. Eng. **17**, 463 (1978)
- 2.57 W.W. Simmons, J.T. Hunt, W.E. Warren: IEEE J. Quantum Electron. **QE-17**, 1727 (1981)
- 2.58 J.H. Campbell, T. Suratwala, C. Thorsness, P. Ehrmann, W. Steele, M. McLean: ICF Quarterly Report, Vol. 9, Jan–March 1999, p. 111, Lawrence Livermore Laboratory
- 2.59 C.F. Rapp: In *Handbook of Laser Science and Technology*, Vol. 5, Pt. 3, ed. by M.J. Weber (CRC Press, Boca Raton, FL, 1987) pp. 339–372
- 2.60 W.F. Krupke: IEEE J. Quantum Electron. **QE-10**, 450 (1974)
- 2.61 E.V. Zharikov, N.N. Il'ichev, V.V. Laptev, A.A. Mayutin, V.G. Ostroumov, P.P. Pashinin, I.A. Shcherbakov: Sov. J. Quantum Electron. **12**, 338–341 (1982)

- 2.62 D. Pruss, G. Huber, A. Beimowski: Appl. Phys. B **28**, 355–358 (1982)
- 2.63 D.S. Sumida, D.A. Rockwell: In *CLEO'86*, San Francisco, CA, 1986, Paper WQ3
- 2.64 P. Fuhrberg, W. Luhs, B. Struve, G. Litfin: In *Tunable Solid-State Lasers II*, ed. by A.B. Budgor, L. Esterowitz, L.G. DeShazer, (Springer, Berlin, 1987) Springer Ser. Opt. Sci., Vol. 52
- 2.65 Medium average power solid-state laser, Technical Information Seminar October, 1985, Lawrence Livermore National Laboratory
- 2.66 J.Y. Liu, C. Liu, M.G. Cohen: In *CLEO'86*, San Francisco, CA, 1986, Paper TuK33
- 2.67 E. Reed: IEEE J. Quantum Electron. **QE-21**, 1625 (1985)
- 2.68 S. Jackel, I. Moshe, R. Lallouz: In *OSA TOPS, Vol. 19, Adv. Solid State Lasers*, ed. by W.R. Bosenberg, M.M. Fejer (Optic Society of America, 1998)
- 2.69 L. Fornasiero, T. Kellner, S. Kueck, J.P. Meyn, P.E. Moebert, G. Huber: Appl. Phys. B **68**, 67 (1999)
- 2.70 Y. Louyer, P. Juncar, M. Himbert, M. Plimmer, F. Balembois, P. Georges: In *Adv. Solid-State Photonics*, San Antonio, TX, 2003, Tech Digest, Paper MB6- 1
- 2.71 J.R. Lincoln, A.I. Ferguson: Opt. Lett. **19**, 1213, (1994)
- 2.72 G.R. Morrison, M. Ebrahimzadeh, C.F. Rae, M.H. Dunn: Opt. Comm. **118**, 55 (1995)
- 2.73 E.P. Chicklis: Private communication (1991)
- 2.74 M.G. Knights, G.A. Rines, J. McCarthy, T. Pollak, K.A. Smith, E.P. Chicklis: In *CLEO'84*, Anaheim, CA, 1984, Paper WM1
- 2.75 M.G. Knights, M.D. Thomas, E.P. Chicklis, G.A. Rines, W. Seka: IEEE J. Quantum Electron. **QE-24**, 712 (1988)
- 2.76 T.M. Pollak, W.F. Wing, R.J. Grasso, E.P. Chicklis, H.P. Jenssen: IEEE J. Quantum Electron. **QE-18**, 159–163 (1982)
- 2.77 R.A. Fields, M. Birnbaum, C.L. Fincher: Appl. Phys. Lett. **51**, 1885 (1987)
- 2.78 L. De Shazer: Laser Focus World, p. 88 (February 1994)
- 2.79 A. Brignon, G. Feugnet, J.P. Huignard, J.P. Pocholle: IEEE J. Quantum Electron. **QE-34**, 577 (1998)
- 2.80 A.I. Zagumennyi, V.A. Mikhailov, I.A. Shcherbakov: Laser Phys. **6**, 582 (1996)
- 2.81 Y.F. Chen: IEEE J. Quantum Electron. **35**, 234 (1999)
- 2.82 X. Peng, L. Xu, A. Asundi: IEEE J. Quantum Electron. **38**, 1291 (2002)
- 2.83 A. Di Lieto, P. Minguzzi, A. Pirastu, V. Magni: IEEE J. Quantum Electron. **39**, 903 (2003)
- 2.84 Y. Sato, T. Taira, N. Pavel, V. Lupei: Appl. Phys. Lett. **82**, 844 (2003)
- 2.85 V. Lupei, N. Pavel, T. Taira: IEEE J. Quantum Electron. **38**, 240 (2002)
- 2.86 Y.F. Chen, T.M. Huang, C.C. Liao, Y.P. Lan, S.C. Wang: IEEE Photon. Technol. Lett. **11**, 1241 (1999)
- 2.87 Y.F. Chen, Y.P. Lan, S.C. Wang: Opt. Lett. **25**, 1016 (2000)
- 2.88 Y.F. Chen, S.W. Tsai, Y.P. Lan, S.C. Wang, K.F. Huang: Opt. Lett. **26**, 199 (2001)
- 2.89 W.L. Nighan, N. Hodgson, E.Chen, D. Dudley: In *Conf. on Lasers and Electro-Optics (CLEO)*, Baltimore, MD, 1999, Paper CMA 1
- 2.90 L. Gonzalez, K. Kleine, L.R. Marshall: In *Conf. on Lasers and Electro-Optics (CLEO)*, Baltimore, MD, 1999, Paper CMA 2
- 2.91 E.V. Zharikov, V.I. Zhekov, L.A. Kulevskii, T.M. Murina, V.V. Osiko, A.M. Prokhorov, A.D. Savel'ev, V.V. Smirnov, B.P. Starikov, M.I. Timoshechkin: Sov. J. Quantum Electron. **4**, 1039 (1975)
- 2.92 V. Lupei, S. Georgescu: Opt. Eng. **35**, 1265 (1996)
- 2.93 B. Majaron, T. Rupnik, M. Lukac: IEEE J. Quantum Electron. **32**, 1636 (1996)
- 2.94 M. Bass, Wei-Qiang Shi, R. Kurtz, M. Kokta, H. Diegl: In *CLEO'86*, San Francisco, CA, 1986, Postdeadline paper ThT1-1
- 2.95 C. Ziolek, H. Ernst, G.F. Will, H. Lubatschowski, H. Welling, W. Ertmer: In *Adv. Solid-State Lasers*, Seattle, WA, 2001, Tech. Digest, p. 9
- 2.96 D.W. Chen, C.L. Fincher, T.S. Rose, F.L. Vernon, R.A. Fields: Opt. Lett. **24**, 385 (1999)
- 2.97 A. Hoegele, G. Hoerbe, H. Lubatschowski, H. Welling, W. Ertmer: Opt. Comm. **125**, 90 (1996)

- 2.98 K.L. Vodopyanov, R. Shori, O.M. Stafsudd: *Appl. Phys. Lett.* **72**, 2211 (1998)
- 2.99 A. Dergachev, P. Moulton: In *Adv. Solid-State Photonics*, 2003, San Antonio, Texas, Tech. Digest, paper PD10-1
- 2.100 J.A. Hutchinson, M. Birnbaum, K. Spariosu, R. Stoltz, B. Zandi, D.S. Anker, T. Allik: In *Proc. IRIS Active Systems*, 1993, vol. II, p. 103
- 2.101 R. Wu, J.D. Myers, M.J. Myers: In *Proc. SPIE Conf. on Solid State Lasers VIII*, San Jose, CA, 1999, vol. 361, p. 221
- 2.102 W. Trussell, V. King, A. Hays, A. Hutchinson, S. Hamilin: In *Adv. Solid-State Photonics*, San Antonio, 2003, paper MA1-1, Tech. Digest
- 2.103 L.F. Johnson, R.E. Dietz, H.J. Guggenheim: *Phys. Rev. Lett.* **11**, 318–320 (1963)
- 2.104 L.F. Johnson, H.J. Guggenheim: *J. Appl. Phys.* **38**, 4837 (1967)
- 2.105 L.F. Johnson, H.J. Guggenheim: *IEEE J. Quantum Electron.* **QE-10** 442 (1974)
- 2.106 J.C. Walling, H.P. Jenssen, R.C. Morris, E.W. O'Dell, O.G. Peterson: *Opt. Lett.* **4**, 182–183 (1979)
- 2.107 J.C. Walling, O.G. Peterson, H.P. Jenssen, R.C. Morris, E.W. O'Dell: *IEEE J. Quantum Electron.* **QE-16**, 1302–1315 (1980)
- 2.108 P.F. Moulton, A. Mooradian: In *Laser Spectroscopy IV*, ed. by H. Walther, K.W. Rothe, (Springer, Berlin, 1979) Springer Ser. Opt. Sci., Vol. 21, pp. 584–589
- 2.109 P.F. Moulton: *Opt. News* **8**, 9 (1982)
- 2.110 B. Struve, G. Huber: *Appl. Phys. B* **30**, 117–120 (1983)
- 2.111 B. Struve, G. Huber: In *12th Int'l Quantum Electr. Conf.*, 1982, Paper ThR- 5
- 2.112 E.V. Zharikov, V.V. Laptev, E.I. Sidorova, Yu P. Timofeev, I.A. Shcherbakov: *Sov. J. Quantum Electron.* **12**, 1124 (1982)
- 2.113 H.P. Christensen, H.P. Jenssen: *IEEE J. Quantum Electron.* **QE-18**, 1197–1201 (1982)
- 2.114 U. Brauch, U. Dürr: *Opt. Commun.* **49**, 61 (1984)
- 2.115 H.R. Verdun, L.M. Thomas, D.M. Andrauskas, T. McCollum, A. Pinto: *Appl. Phys. Lett.* **53**, 2593 (1988)
- 2.116 V. Petricevic, S.K. Gayen, R.R. Alfano: *Appl. Phys. Lett.* **53**, 2590 (1988)
- 2.117 V. Petricevic, S.K. Gayen, R.R. Alfano: *Appl. Phys. Lett.* **52**, 1040 (1988)
- 2.118 J.G. Daly, C.A. Smith: *2 Micron Laser Applications*, SPIE Proc., Vol. 1627, ed. by J. Quarles (SPIE, Bellingham, WA, 1992) p.26, see also: Data sheet: Co-Lasers, Schwartz Electro-Optics, Inc.
- 2.119 B.T. McGuckin, R.T. Menzies: *IEEE J. Quantum Electron.* **QE-28**, 1025 (1992)
- 2.120 U. Brauch, A. Giesen, M. Karszewski, Chr. Stewen, A. Voss: *Opt. Lett.* **20**, 713 (1995)
- 2.121 J.C. Walling, O.G. Peterson, H.P. Jenssen, R.C. Morris, E.W. O'Dell: *IEEE J. Quantum Electron.* **QE-16**, 1302 (1980)
- 2.122 H. Samelson, J.C. Walling, D.F. Heller: *SPIE Proc.* **335**, 85 (1982)
- 2.123 R. Scheps, B.M. Gately, J.F. Myers, J.S. Krasinski, D.F. Heller: *Appl. Phys. Lett.* **56**, 2288 (1990)
- 2.124 S. Guch: In *CLEO'83*, Baltimore, MA, 1983, Paper ThR3
- 2.125 R.C. Sam, J.J. Yeh, K.R. Leslie, W.R. Rapoport: *IEEE J. Quantum Electron.* **QE-24**, 1151 (1988)
- 2.126 P.F. Moulton: *J. Opt. Soc. Am. B* **3**, 125 (1986); and *Laser Focus* **14**, 83 (1983)
- 2.127 E.G. Erickson: In *OSA Proc. on Tunable Solid State Lasers*, North Falmouth MA, 1989, Vol. 5, p. 26
- 2.128 A. Hoffstädt: *IEEE J. Quantum Electron.* **QE-33**, 1850 (1997)
- 2.129 R. Rao, G. Vaillancourt, H.S. Kwok, C.P. Khattak: In *OSA Proc. on Tunable Solid State Lasers*, North Falmouth, MA, 1989, Vol. 5, p. 39
- 2.130 T.R. Steele, D.C. Gerstenberger, A. Drobshoff, R.W. Wallace: *Opt. Lett.* **16**, 399 (1991)
- 2.131 G.T. Maker, A.I. Ferguson: *Opt. Lett.* **15**, 375 (1990)
- 2.132 J. Harrison, A. Finch, D.M. Rines, G.A. Rines, P.F. Moulton: *Opt. Lett.* **16**, 581 (1991)
- 2.133 S.A. Payne, L.L. Chase, L.K. Smith, W.L. Kway, H.W. Newkirk: *J. Appl. Phys.* **66**, 1051 (1989)
- 2.134 S.A. Payne, L.L. Chase, H.W. Newkirk, L.K. Smith, W.F. Krupke: *IEEE J. Quantum Electron.* **QE-24**, 2243 (1988)
- 2.135 P.A. Beaud, M. Richardson, E.J. Miesak: *IEEE J. Quantum Electron.* **QE-31**, 317 (1995)

- 2.136 M. Richardson, V. Castillo, P. Beaud, M. Bass, B. Chai, G. Quarles, W. Ignatuk: *Photonics Spectra*, p. 86 (October 1993)
- 2.137 R. Scheps, J.F. Myers, H. Serreze, A. Rosenberg, R.C. Morris, M. Long: *Opt. Lett.* **16**, 820 (1991)
- 2.138 Q. Zhang, B.H.T. Chai, G.J. Dixon: In *CLEO '91*, Baltimore, MD, 1991, Paper CThR6
- 2.139 S.A. Payne, W.F. Krupke, L.K. Smith, W.L. Kway, L.D. DeLoach, J.B. Tassano: *IEEE J. Quantum Electron.* **QE-28**, 1188 (1992)
- 2.140 R. Mellish, S.C.W. Hyde, N.P. Barry, R. Jones, P.M.W. French, J.R. Taylor, C.J. van der Poel, A. Valster: *Appl. Phys. B, Lasers Opt.* **65**, 221 (1997)
- 2.141 D. Kopf, K.J. Weingarten, G. Zhang, M. Moser, M.A. Emanuel, R.J. Beach, J.A. Skidmore, U. Keller: *Appl. Phys. B, Lasers Opt.* **65**, 235 (1997)
- 2.142 D. Kopf, A. Prasad, G. Zhang, M. Moser, U. Keller: *Opt. Lett.* **22**, 621 (1997)
- 2.143 P.J.M. Suni, S.W. Henderson: *Opt. Lett.* **16**, 817 (1991)
- 2.144 E.C. Honea, R.J. Beach, S.B. Sutton, J.A. Speth, S.C. Mitchell, J.A. Skidmore, M.A. Emanuel, S.A. Payne: *IEEE J. Quantum Electron.* **QE-33**, 1592 (1997); and in *TOPS, Advanced Solid State Lasers*, Vol. 10 (Opt. Soc. Am., Washington, DC, 1997) p. 307
- 2.145 G. Rustad, H. Hovland, K. Stenersen: In *OSA Advanced Solid State Lasers*, San Francisco, CA, 1996, Techn. digest, p. 48
- 2.146 R.C. Stoneman, L. Esterowitz: *Opt. Lett.* **15**, 486 (1990)
- 2.147 T. Yokozawa, H. Hara: *Appl. Opt.* **35**, 1424 (1996)
- 2.148 I.F. Elder, M.J.P. Payne: In *OSA Advanced Solid State Lasers*, San Francisco, CA, 1996 Techn. digest, p. 30; also *Appl. Opt.* **36**, 8606 (1997)
- 2.149 P.A. Budni, M.L. Lemons, J.R. Mosto, E.P. Chicklis: *IEEE J. Select. Topics Quantum Electron.* **6**, 629 (2000)
- 2.150 A. Dergachev, K. Wall, P.F. Moulton: In *OSA Trends in Optics and Photonics, Vol. 68, Adv. Solid State Lasers*, ed. by M.E. Fermann, L.R. Marshall (Optic Society of America, 2002) p. 343
- 2.151 J. Yu, U.N. Singh, N.P. Barnes, M. Petros: *Opt. Lett.* **23**, 780 (1998)
- 2.152 A. Finch, J.H. Flint: In *OSA Advanced Solid State Lasers*, San Francisco, CA, 1996, Techn. digest, p. 253
- 2.153 M.E. Storm: *IEEE J. Quantum Electron.* **QE-29**, 440 (1993)
- 2.154 T.S. Kubo, T.J. Kana: *IEEE J. Quantum Electron.* **QE-28**, 1033 (1992)
- 2.155 K.S. Lai, P.B. Phua, R.F. Wu, Y.L. Lim, E. Lau, S.W. Toh, B.T. Toh, A. Chng: *Opt. Lett.* **25**, 1591 (2000)
- 2.156 W.F. Krupke: *IEEE J. Select. Topics Quantum Electron.* **QE-6**, 1287 (2000)
- 2.157 D.S. Sumida, T.Y. Fan: In *Proc. Advanced Solid State Lasers*, Vol. 20 (Opt. Soc. Am., Washington, DC, 1994) p. 100; and *Opt. Lett.* **20**, 2384 (1995)
- 2.158 M. Karszewski, U. Brauch, K. Contag, A. Giesen, I. Johannsen, C. Stewen, A. Voss: In *OSA Advanced Solid State Lasers*, Coeur d'Alene, ID, 1998, Techn. Digest, p. 82
- 2.159 D.S. Sumida, H. Bruesselbach, R.W. Byren, M. Mangir, R. Reeder: *Proc. SPIE*, **3265**, 100 (1998)
- 2.160 C. Bibeau, R. Beach, C. Ebberts, M. Emanuel, J. Skidmore: In *TOPS Advanced Solid State Lasers*, Vol. 10 (Opt. Soc. Am., Washington, DC, 1997) p. 276
- 2.161 E.C. Honea, R.J. Beach, S.C. Mitchell, J. Skidmore, M.A. Emanuel, S.B. Sutton, S.A. Payne, P.V. Avizonis, R.S. Monroe, D.G. Harris: *Opt. Lett.* **25**, 805 (2000)
- 2.162 A. Giesen, M. Karszewski, C. Stewen, A. Voss: In *Proc. on Advanced Solid State Lasers*, Vol. 24 (Opt. Soc. Am., Washington, DC, 1995) p. 330
- 2.163 A. Giesen, M. Brauch, I. Johannsen, M. Karszewski, U. Schiegg, C. Stewen, A. Voss: In *TOPS Advanced Solid State Lasers*, Vol. 10 (Opt. Soc. Am., Washington, DC, 1997) p. 280
- 2.164 C. Stewen, K. Contag, M. Larionov, A. Giesen, H. Huegel: *IEEE J. Select. Topics Quantum Electron.* **6**, 650 (2000)

Chapter 3

- 3.1 W.W. Rigrod: *J. Appl. Phys.* **36**, 2487 (1965)
- 3.2 A.Y. Cabezas, R.P. Treat: *J. Appl. Phys.* **37**, 3556 (1966)

- 3.3 Yu. Kalinin, A.A. Mak: Opt. Tech. **37**, 129 (1970)
- 3.4 D. Findlay, R.A. Clay: Phys. Lett. **20**, 277 (1966)
- 3.5 T.Y. Fan, R.L. Byer: IEEE J. Quantum Electron. **QE-24**, 895 (1988)
- 3.6 R. Dunsmuir: J. Electron. Control **10**, 453 (1961)
- 3.7 H. Statz, G.A. Mars, D.T. Wilson, C.L. Tang: J. Appl. Phys. **36**, 1510 (1965)
- 3.8 T.J. Kane: IEEE Photon. Technol. Lett. **2**, 244 (1990)
- 3.9 K. Tsubono, S. Moriwaki: Jpn. J. Appl. Phys. **31**, 1241 (1992)
- 3.10 C.C. Harb, M.B. Gray, H.A. Bachor, R. Schilling, P. Rottengatter, I. Freitag, H. Welling: IEEE J. Quantum Electron. **QE-30**, 2907 (1994)
- 3.11 L.W. Casperson: J. Appl. Phys. **47**, 4555 (1976)
- 3.12 A. Owyong, G.R. Hadley, R. Esherrick, R.L. Schmitt, L.A. Rahn: Opt. Lett. **10**, 484 (1985)
- 3.13 J.M. Eggleston, L. DeShazer, K. Kangas: IEEE J. Quantum Electron. **QE-24**, 1009 (1988)
- 3.14 R. Burnham, Private Communication 1989, also A.D. Hays, R. Burnham, G.L. Harnagel: In *CLEO '89* (Baltimore, MA) Postdeadline paper PO 9-1
- 3.15 W. Koehner, H.R. Verdun: Diode laser pumped solid-state lasers, Final Rept. Contract N00014-85-C-0174, Naval Oceans Systems Command, San Diego, CA (1987)
- 3.16 N. Barnes, M. Storm, P. Cross, M. Skolaut: IEEE J. Quantum Electron. **QE-26**, 558 (1990)
- 3.17 D.L. Sipes: Appl. Phys. Lett. **47**, 74-76 (1985)
- 3.18 W.L. Nighan, N. Hodgson, E. Cheng, D. Dudley: In *CLEO'99, Conf. on Lasers and Electro-Optics*, Baltimore, MD, May 1999, Tech. Digest, p. 1
- 3.19 R.A. Fields, M. Birnbaum, C.L. Fincher: In *CLEO '87* (Baltimore, MD)
- 3.20 N. Mermilliod, R. Romero, I. Chartier, C. Garapon, R. Moncorgé: IEEE J. Quantum Electron. **QE-28**, 1179 (1992)
- 3.21 K.X. Liu, C.J. Flood, D.R. Walker, H.M. van Driel: Opt. Lett. **17**, 1361 (1992)
- 3.22 J.R. Lincoln, A.I. Ferguson: Opt. Lett. **19**, 2119 (1994)
- 3.23 R. Mellisk, P.M.W. French, J.R. Taylor, P.J. Delfyett, L.T. Florez: In *Proc. Adv. Solid State Lasers*, Vol. 20 (Opt. Soc. Am., Washington, DC, 1994) p. 239
- 3.24 D. Kopf, K.J. Weingarten, L.R. Brovelli, M. Kamp, U. Keller: Opt. Lett. **19**, 2143 (1994)
- 3.25 E.C. Honea, C.A. Ebberts, R.J. Beach, J.A. Speth, J.A. Skidmore, M.A. Emanuel, S.A. Payne: Opt. Lett. **23**, 1203 (1998)
- 3.26 C. Bibeau, R. Beach, C. Ebberts, M. Emanuel, J. Skidmore: In *TOPS, Vol. 10: Advanced Solid State Lasers* (Opt. Soc. Am., Washington, DC, 1997) p. 276
- 3.27 E.C. Honea, R.J. Beach, S.B. Sutton, J.A. Speth, S.C. Mitchell, J.A. Skidmore, M.A. Emanuel, S.A. Payne: IEEE J. Quantum Electron. **QE-33**, 1592 (1997)
- 3.28 A.R. Clobes, M.J. Brienza: Appl. Phys. Lett. **21**, 265 (1972)
- 3.29 A.M. Bonch-Bruевич, V. Yu. Petrun'kin, N.A. Esepkina, S.V. Kruzhalov, L.N. Pakhomov, V.A. Chernov, S.L. Galkin: Sov. Phys.-Tech. Phys. **12**, 1495 (1968)
- 3.30 T.J. Kane, R.L. Byer: Opt. Lett. **10**, 65 (1985)
- 3.31 W.R. Trutna, D.K. Donald, M. Nazarathy: Opt. Lett. **12**, 248 (1987)
- 3.32 A.C. Nilsson, E.K. Gustafson, R.L. Byer: IEEE J. Quantum Electron. **QE-25**, 767 (1989)
- 3.33 T.J. Kane, E.A.P. Cheng: Opt. Lett. **13**, 970 (1988)
- 3.34 D.G. Scerbak: In *Solid-State Lasers*, SPIE Proc., Vol. 1223, ed. by G. Dubé (1990) p. 196
- 3.35 J. Harrison, G.A. Rines, P.F. Moulton, J.R. Leger: Opt. Lett. **13**, 111 (1988)
- 3.36 R. Scheps, J. Myers: In *Solid-State Lasers*, SPIE Proc., Vol. 1223, ed. by G. Dubé (1990) p. 186
- 3.37 M.D. Selker, T.J. Johnston, G. Frangineas, J.L. Nightingale, D.K. Negus: In *Conf. on Lasers and Electro-Optics (CLEO)*, Anaheim, CA, June 1996, Tech. Digest, p. 602

Chapter 4

- 4.1 L.M. Frantz, J.S. Nodvik: J. Appl. Phys. **34**, 2346 (1963)
- 4.2 P.G. Kriukov, V.S. Letokhov: In *Laser Handbook I*, ed. by E.T. Arecchi, E.O. Schulz-DuBois (North-Holland, Amsterdam, 1972) pp. 561-595
- 4.3 P.V. Avizonis, R.L. Grotbeck: J. Appl. Phys. **37**, 687 (1966)

- 4.4 T.G. Crow, T.J. Snyder: Techniques for achieving high-power Q-switched operation in YAG:Nd. Final Tech. Report AFAL-TR-70-69, Air Force, WPAFB (1970); and *Laser J.* **18**, (1970)
- 4.5 W. Koechner, R. Burnham, J. Kasinski, P. Bournes, D. DiBiase, K. Le, L. Marshall, A. Hays: In *Proc. Int'l. Conf. Optical Space Com.*, Munich, 10–14 June 1991, ed. by J. Franz (SPIE, Bellingham, WA, 1991), SPIE Proc., Vol. 1522, p. 169
- 4.6 C. Bibeau, D.R. Speck, R.B. Ehrlich, C.W. Laumann, D.T. Kyrakis, M.A. Hennesian, J.K. Lawson, M.D. Perry, P.J. Wegner, T.L. Weiland: *Appl. Opt.* **31**, 5799 (1992)
- 4.7 B.M. Van Wonerghem, J.R. Murray, J.H. Campbell, D.R. Speck, C.E. Barker, I.C. Smith, D.F. Browning, W.C. Behrendt: *Appl. Opt.* **36**, 4932 (1997)
- 4.8 Lawrence Livermore Lab. Laser Program Annual Reports UCRL-50021 and UCRL-LR-105821
- 4.9 W.E. Martin, D. Milam: *IEEE J. Quantum Electron.* **QE-18**, 1155 (1982)
- 4.10 C. Yamanaka, Y. Kato, Y. Izawa, K. Yoshida, T. Yamanaka, T. Sasaki, M. Nakatsuka, T. Mochizuki, J. Kuroda, S. Nakai: *IEEE J. Quantum Electron.* **QE-17**, 1639 (1981)
- 4.11 Chen, Y. Bai, J. Yu, U. Singh, M. Petros: In *Advanced Solid State Photonics*, San Antonio, TX, Feb. 2003, OAS Topical Mtg., Tech. Digest, p. 276
- 4.12 H. Kiriya, K. Yamakawa, T. Nagai, N. Kageyama, H. Miyajima, H. Kan, H. Yoshida, M. Nakatsuka: *Opt. Lett.* **28**, 1671, 2003
- 4.13 S. Saraf, S. Sinha, A. Sridharan, R. Byer: In *Advanced Solid State Photonics*, San Antonio, TX, Feb. 2003, OAS Topical Mtg., Tech. Digest, p. 387
- 4.14 K.J. Snell, D. Lee, K.F. Wall, P.F. Moulton: In *OSA Trends in Optics and Photonics, Vol. 34, Advanced Solid State Lasers* (OSA, Washington, DC, 2000) p. 55
- 4.15 K.J. Snell, D. Lee: In *OSA Trends in Optics and Photonics, Vol. 26, Advanced Solid State Lasers* (OSA, Washington, DC, 1999) p. 295
- 4.16 B. Pati, Y. Isyanova, P. Moulton: In *Advanced Solid State Photonics*, San Antonio, TX, Feb. 2003, OAS Topical Mtg., Tech. Digest, p. 179
- 4.17 W.B. Jones, L.M. Goldman, J.P. Chernoch, W.S. Martin: *IEEE J. Quantum Electron.* **QE-8**, 534 (1972)
- 4.18 A. Yu. Dergachev, J.H. Flint, P.F. Moulton: In *CLEO Technical Digest* (OSA, Washington, DC, 2000) p. 564
- 4.19 T. Axenson, N. Barnes, D. Reichle: In *Advanced Solid State Photonics*, San Antonio, TX, Feb. 2003, OAS Topical Mtg., Postdeadline paper, Tech. Digest, p. 55
- 4.20 D. Mueller, S. Erhard, O. Ronsin, A. Giesen: In *Advanced Solid State Photonics*, San Antonio, TX, Feb. 2003, OAS Topical Mtg., Tech. Digest, p. 255
- 4.21 S. Forget, F. Balembois, P. Georges: In *OSA Proceedings*, Washington, DC, 2002, Vol. 68, p. 321
- 4.22 M. Gifford, K.J. Weingarten: *Opt. Lett.* **17**, 1788 (1992)
- 4.23 W.H. Lowdermilk, J.E. Murray: *J. Appl. Phys.* **51**, 2436 (1980)
- 4.24 J.E. Murray, W.H. Lowdermilk: *J. Appl. Phys.* **51**, 3548 (1980)
- 4.25 L. Turi, T. Juhasz: *Opt. Lett.* **20**, 154 (1995)
- 4.26 D.R. Walker, C.J. Flood, H.M. Van Driel, U.J. Greiner, H.H. Klingenberg: In *CLEO/Europe'94*, Amsterdam, 1994, Paper CThM1
- 4.27 M.D. Selker, R.S. Afzal, J.L. Dallas, A.W. Yu: *Opt. Lett.* **19**, 551 (1994)
- 4.28 M. Rhoades, K. Le, D. DiBiase, P. Bournes, W. Koechner, R. Burnham: In *Laser'95, Munich*, 1995, paper F
- 4.29 A.Y. Cabezas, R.P. Treat: *J. Appl. Phys.* **37**, 3556 (1966)
- 4.30 C. Kennedy: In *Advanced Solid State Photonics*, San Antonio, TX, Feb. 2003, OAS Topical Mtg., Tech. Digest, p. 217
- 4.31 D. Hoffmann, G. Bonati, P.F. Kayser, P. Loosen, R. Poprawe, R. Dinger, C.R. Haas, H. Martinen: In *Adv. Solid State Lasers*, TOPS Vol. 50 (Optical Soc. America 2001) p. 33
- 4.32 J. Bunkenberg, J. Boles, D.C. Brown, J. Eastman, J. Hoose, R. Hopkins, L. Iwan, S.D. Jacobs, J.H. Kelly, S. Kumpan, S. Letzring, D. Lonobile, L.D. Lund, G. Mourou, S. Reformat, S. Seka, J.M. Soares, K. Walsh: *IEEE J. Quantum Electron.* **QE-17**, 1620 (1981)

- 4.33 G.J. Linford, E.R. Peressini, W.R. Sooy, M.L. Spaeth: Appl. Opt. **13**, 379 (1974)
- 4.34 N.P. Barnes, V.J. Corcoran, I.A. Crabbe, L.L. Harper, R.W. Williams, J.W. Wragg: IEEE J. **QE-10**, 195 (1974)
- 4.35 E. Bridges, R.W. Boyd, G.P. Agrawal: Opt. Lett. **18**, 2026 (1993)
- 4.36 G. Fibich, A.L. Gaeta: Opt. Lett. **25**, 335 (2000)
- 4.37 S.A. Akhmanov, R.V. Khokhlov, A.P. Sukhorukov: In *Laser Handbook*, ed. by E.T. Arecchi, E.O. Schulz-DuBois (North-Holland, Amsterdam, 1972) p. 1151
- 4.38 R. DeSalvo, A.A. Said, D.J. Hagan, E.W. Van Stryland, M. Sheik-Bahae, IEEE J. Quantum Electron. **QE-32**, 1324 (1996)
- 4.39 Data sheets Schott and Hoya laser glasses
- 4.40 G. Arisholm: In *OSA TOPS, Vol. 10, Advanced Solid State Lasers* (Optical Soc. Am., 1997) p. 109
- 4.41 R.W. Boyd: *Nonlinear Optics* (Academic, San Diego, CA, 1992)
- 4.42 J. Herrmann: Opt. Commun. **98**, 111 (1993)
- 4.43 V.I. Bespalov, V.I. Talanov: JETP Lett. **3**, 307 (1966)
- 4.44 J.A. Glaze: High energy glass lasers: Proc. Soc. Photo-Opt. Instr. Eng. **69**, 45 (1975)
- 4.45 A.J. Campillo, S.L. Shapiro, B.R. Suydam: Appl. Phys. Lett. **24**, 178 (1974); and Appl. Phys. Lett. **23**, 628 (1973)
- 4.46 E.S. Bliss, D.R. Speck, J.F. Holzrichter, J.H. Erkkila, A.J. Glass: Appl. Phys. Lett. **25**, 448 (1974)
- 4.47 W.W. Simmons, J.T. Hunt, W.E. Warren: IEEE J. Quantum Electron. **QE-17**, 1727 (1981)
- 4.48 J.T. Hunt, D.R. Speck: Opt. Eng. **28**, 461 (1989)
- 4.49 J.T. Hunt, K.R. Manes, P.A. Renard: Appl. Opt. **32**, 5973 (1993)
- 4.50 D.R. Speck, E.S. Bliss, J.A. Glaze, J.W. Herris, F.W. Holloway, J.T. Hunt, B.C. Johnson, D.J. Kuizenga, R.G. Ozarski, H.G. Patton, P.R. Rupert, G.J. Suski, C.D. Swift, C.E. Thompson: IEEE J. Quantum Electron. **QE-17**, 1599 (1981)
- 4.51 U. Roth, F. Loewenthal, R. Tommasini, J.E. Balmer, H.P. Weber: IEEE J. Quantum Electron. **36**, 687 (2000)
- 4.52 O.A. Konoplev, D.D. Meyerhofer: IEEE J. Select. Topics Quantum Electron. **4**, 459 (1998)
- 4.53 K. Beckwitt, F.W. Wise, L. Qian, L.A. Walker, E. Canto-Said: Opt. Lett. **26**, 1696 (2001)

Chapter 5

- 5.1 A.G. Fox, T. Li: Bell Syst. Tech. J. **40**, 453 (1961)
- 5.2 G.D. Boyd, J.P. Gordon: Bell Syst. Tech. J. **40**, 489 (1961)
- 5.3 G.D. Boyd, H. Kogelnik: Bell Syst. Tech. J. **41**, 1347 (1962)
- 5.4 K. Kogelnik, T. Li: Appl. Opt. **5**, 1550 (1966); and Proc. IEEE **54**, 1312 (1966)
- 5.5 H. Kogelnik: In *Lasers I*, ed. by A.K. Levine (Dekker, New York, 1966) pp. 295–347
- 5.6 J.S. Kruger: Electro-Opt. Syst. Design 12 (September 1972)
- 5.7 R.J. Freiberg, A.S. Halsted: Appl. Opt. **8**, 335 (1969)
- 5.8 T. Li: Bell Syst. Tech. J. **44**, 917 (1965)
- 5.9 D.E. McCumber: Bell Syst. Tech. J. **44**, 333 (1965)
- 5.10 R.L. Phillips, L.C. Andrews: Appl. Opt. **22**, 643 (1983)
- 5.11 W.H. Carter: Appl. Opt. **19**, 1027 (1980)
- 5.12 A.E. Siegman, S.W. Townsend: IEEE J. Quantum Electron. **29**, 1212 (1993)
- 5.13 H. Kogelnik: Bell Syst. Tech. J. **44**, 455 (1965)
- 5.14 H. Steffen, J.P. Lörtcher, G. Herziger: IEEE J. Quantum Electron. **QE-8**, 239 (1972)
- 5.15 R.B. Chesler, D. Maydan: J. Appl. Phys. **43**, 2254 (1972)
- 5.16 N.K. Berger, N.A. Deryugin, Y.N. Lukyanov, Y.E. Studenikin: Opt. Spectrosc. USSR **43**, 176 (1977)
- 5.17 R. Hauck, H.P. Kortz, H. Weber: Appl. Opt. **19**, 598 (1980)
- 5.18 I.M. Belousova, O.B. Danilov: Soc. Phys. **12**, 1104 (1968)

- 5.19 E.A. Teppo: Nd:YAG laser laboratory experiments, Tech. Note 4051-2 (February 1972); and Tech. Note 4051-7, Naval Weapons Center, China Lake, CA (August 1973)
- 5.20 J.E. Geusic, H.J. Levingstein, S. Singh, R.C. Smith, L.G. Van Uitert: Appl. Phys. Lett. **12**, 306 (1968)
- 5.21 H.P. Kortz, R. Iffländer, H. Weber: Appl. Opt. **20**, 4124 (1981)
- 5.22 V. Magni: Appl. Opt. **25**, 107 (1986); and **25**, 2039 (1986)
- 5.23 V. Magni, G. Valentini, S. DeSilvestri: Opt. Quantum Electron. **23**, 1105 (1991)
- 5.24 S. DeSilvestri, P. Laporta, V. Magni: IEEE J. Quantum Electron. **QE-23**, 1999 (1987); and Opt. Lett. **11**, 513 (1986)
- 5.25 N. Pavel, T. Dascalu, V. Lupei: Opt. Eng. **35**, 1239 (May 1996)
- 5.26 D.C. Hanna, S.G. Sawyers, M.A. Yuratich: Opt. Quantum Electron. **13**, 493 (1981)
- 5.27 D.C. Hanna, S.G. Sawyers, M.A. Yuratich: Opt. Commun. **37**, 359 (1981)
- 5.28 P.H. Sarkies: Opt. Commun. **31**, 189 (1979)
- 5.29 H.W. Kogelnik, E.P. Ippen, A. Dienes, C.V. Shank: IEEE J. Quantum Electron. **QE-8**, 373 (1972)
- 5.30 D. Hanna: IEEE J. Quantum Electron. **QE-5**, 483 (1969)
- 5.31 A. Yariv, Optical Electronics, 4th edn. (Holt, Rinehart and Winston, Orlando, FL, 1971)
- 5.32 A.E. Siegman: Lasers, (University Science Book, Mill Valley, CA, 1986)
- 5.33 A.J. Kemp, G.J. Friel, T.K. Lake, R.S. Convooy, B.D. Sinclair: IEEE J. Quantum Electron. **36**, 228 (2000)
- 5.34 Applied Optics Research, Tuscon, AZ (GLAD); Script Enterprises, San Jose, CA (PARAXIA); Micro Systems Design, Munich, Germany (LASXAD); Breault Research Org. Tucson AZ (ASAP)
- 5.35 A. Rapaport, L. Weichman, B. Brickeen, S. Green, M. Bass: IEEE J. Quantum Electron. **37**, 1401 (2001)
- 5.36 F.A. Jenkins, H.E. White: *Fundamentals of Optics* (McGraw-Hill, New York, 1976)
- 5.37 M. Born, E. Wolf: *Principles of Optics* (Pergamon, New York, 1964)
- 5.38 C.L. Tang, H. Statz, G.A. DeMars, D.T. Wilson: Phys. Rev. **136**, A1 (1964)
- 5.39 A.R. Clobes, M.J. Brienza: Appl. Phys. Lett. **21**, 265 (1972)
- 5.40 T.J. Kane, R.J. Byer, Opt. Lett. **10**, 65 (1985)
- 5.41 D.A. Draegert: IEEE J. Quantum Electron. **QE-8**, 235 (1972)
- 5.42 H.G. Danielmeyer, W.G. Nilsen: Appl. Phys. Lett. **16**, 124 (1970)
- 5.43 H.G. Danielmeyer, E.H. Turner: Appl. Phys. Lett. **17**, 519 (1970)
- 5.44 A. Yariv: *Quantum Electronics*, 3rd edn. (Wiley, New York, 1988)
- 5.45 B. Zhou, T.J. Kane, G.I. Dixon, R.L. Byer: Opt. Lett. **10**, 62 (1985)
- 5.46 Y.K. Park, G. Giuliani, R.L. Byer: IEEE J. Quantum Electron. **QE-20**, 117 (1984)
- 5.47 N.P. Barnes, J.C. Barnes: IEEE J. Quantum Electron. **QE-29**, 2670 (1993)
- 5.48 L.A. Rahn: Appl. Opt. **24**, 940 (1985)
- 5.49 S.W. Henderson, E.H. Yuen, E.S. Fry: Opt. Lett. **11**, 715 (1986)
- 5.50 E.S. Fry, Q. Hu, X. Li: Appl. Opt. **30**, 1015 (1991)
- 5.51 V. Evtuhov, A.E. Siegman: Appl. Opt. **4**, 142 (1965)
- 5.52 K. Tsubono, S. Moriwaki: Jpn. J. Appl. Phys. **31**, 1241 (1992)
- 5.53 C.C. Harb, M.B. Gray, H.A. Bachor, R. Schilling, P. Rottengatter, I. Freitag, H. Welling: IEEE J. Quantum Electron. **QE-30**, 2907 (1994)
- 5.54 J. Harrison, A. Finch, J.H. Flint, P.F. Moulton: IEEE J. Quantum Electron. **QE-28**, 1123 (1992)
- 5.55 T.J. Kane, A.C. Nilsson, R.L. Byer: Opt. Lett. **12**, 175 (1987)
- 5.56 J.J. Zayhowski, J.A. Keszenheimer: IEEE J. Quantum Electron. **QE-28**, 1118 (1992)
- 5.57 J.A. Keszenheimer, J.J. Zayhowski: In CLEO '91, Baltimore, MD, 1991, paper CME8
- 5.58 A. Owyong, P. Esherrick: Opt. Lett. **12**, 999 (1987)
- 5.59 T.J. Kane, E.A.P. Cheng: Opt. Lett. **13**, 970 (1988)
- 5.60 W.R. Trutna, D.K. Donald: Opt. Lett. **15**, 369 (1990)
- 5.61 P.A. Schultz, S.R. Henion: Opt. Lett. **16**, 578 (1991)
- 5.62 J.A. Keszenheimer, K.F. Wall, S.F. Root: In *OSA Proc. Adv. Solid-State Lasers*, Vol. 15, (1993) p. 283

- 5.63 P. Robrish: Opt. Lett. **19**, 813 (1994)
- 5.64 R.W.P. Drever, J.L. Hall, F.V. Kowalski, J. Hough, G.M. Ford, A.J. Munley, H. Ward: Appl. Phys. B. **31**, 97 (1983)
- 5.65 T. Day, E.K. Gustafson, R.L. Byer: IEEE J. Quantum Electron. **QE-28**, 1106 (1992)
- 5.66 N. Uehara, K. Ueda: Opt. Lett. **18**, 505 (1993)
- 5.67 K. Nakagawa, A.S. Shelkovich, T. Katsuda, M. Ohtsu: Appl. Opt. **33**, 6383 (1994)
- 5.68 A. Yu Nevsky, M. Eichenseer, J. von Zanthier, H. Walther: Opt. Commun. **210**, 91 (2002)
- 5.69 M. Musha, K. Nakagawa, K. Ueda: Opt. Lett. **22**, 1177 (1997)
- 5.70 B. Willke, S. Brozek, K. Danzmann, V. Quetschke, S. Gossler: Opt. Lett. **5**, (May 2000)
- 5.71 H.A. Macleod: *Thin-Film Optical Filters*, 2nd edn. (MacMillan, New York, 1986)
- 5.72 A.E. Siegman: Proc. IEEE **53**, 277 (1965)
- 5.73 A.E. Siegman: Appl. Opt. **13**, 353 (1974); and *Lasers* (University Science Books, Mill Valley, CA, 1986)
- 5.74 W.H. Steier: In *Laser Handbook*, Vol. 3, ed. by M. Stitch (North-Holland, Amsterdam, 1979)
- 5.75 R.L. Herbst, M. Komine, R.L. Byer: Opt. Commun. **21**, 5 (1977)
- 5.76 E. Armandillo, C. Norrie, A. Cosentino, P. Laporta, P. Wazen, P. Maine: Opt. Lett. **22**, 1168 (1997)
- 5.77 T.F. Ewanizky, J.M. Craig: Appl. Opt. **15**, 1465 (1976)
- 5.78 P.G. Gobbi, S. Morosi, G.C. Reali, A.S. Zarkasi: Appl. Opt. **24**, 26 (1985)
- 5.79 G. Giuliani, Y.K. Park, R.L. Byer: Opt. Lett. **5**, 491 (1980)
- 5.80 J.M. Eggleston, G. Giuliani, R.L. Byer: J. Opt. Soc. Am. **71**, 1264 (1982)
- 5.81 S. De Silvestri, P. Laporta, V. Magni, O. Svelto: Opt. Lett. **12**, 84 (1987)
- 5.82 N. McCarthy, P. Lavigne: Appl. Opt. **22**, 2704–2708 (1983)
- 5.83 N. McCarthy, P. Lavigne: Appl. Opt. **23**, 3845–3850 (1984)
- 5.84 P. Lavigne, N. McCarthy, J.G. Demers: Appl. Opt. **24**, 2581–2586 (1985)
- 5.85 N. McCarthy, P. Lavigne: Opt. Lett. **10**, 553–555 (1985)
- 5.86 A. Parent, P. Lavigne: Appl. Opt. **28**, 901–903 (1989)
- 5.87 G. Emiliani, A. Piegari, S. De Silvestri, P. Laporta, V. Magni: Appl. Opt. **28**, 2832–2837 (1989)
- 5.88 S. De Silvestri, V. Magni, O. Svelto, G. Valentini: IEEE J. Quantum Electron. **QE-26**, 1500 (1990)
- 5.89 N. Hodgson, H. Weber: Opt. Quantum Electron. **22**, 39 (1990)
- 5.90 N. Hodgson, T. Haase: SPIE Proc. **1277**, 88 (1990)
- 5.91 V. Magni, S. DeSilvestri, O. Svelto, G.L. Valentini: Lasers Electro-Opt. **10**, 366 (1991)
- 5.92 V. Magni, S. DeSilvestri, L.-J. Qian, O. Svelto: Opt. Commun. **94**, 87 (1992)
- 5.93 N. Hodgson, G. Bostanjoglo, H. Weber: Opt. Commun. **99**, 75 (1993)
- 5.94 N. Hodgson, G. Bostanjoglo, H. Weber: Appl. Opt. **32**, 5902 (1993)
- 5.95 G. Bostanjoglo, G.A. Witt: Fibertek Report (February **14**, 1994)
- 5.96 W.F. Krupke, W.R. Sooy: IEEE J. Quantum Electron. **QE-5**, 575 (1969)
- 5.97 J.M. Yarborough, J. Hobart: In *Conf. on Laser Eng. Appl.*, Washington, DC, 1973, postdeadline paper
- 5.98 I.J. Hodgkinson, Vukusic: Opt. Commun. **24**, 133 (1978)
- 5.99 A.L. Bloom: J. Opt. Soc. Am. **64**, 447 (1974)

Chapter 6

- 6.1 J.H. Goncz: Instr. Soc. Am. Trans. **5**, 1 (1966)
- 6.2 J.H. Goncz, W.J. Mitchell: IEEE J. Quantum Electron. **QE-3**, 330 (1967)
- 6.3 J. Oliver, F.S. Barnes: IEEE J. Quantum Electron. **QE-5**, 225 (1969)
- 6.4 W.D. Fountain, L.M. Osterink, J.D. Foster: IEEE J. Quantum Electron. **QE-6**, 232, 684 (1970)
- 6.5 M.B. Davies, P. Scharman, J.K. Wright: IEEE J. Quantum Electron. **QE-4**, 424 (1968)
- 6.6 E.A. Teppo: Nd:YAG laser laboratory experiments, Tech. Note 4051-2 (Naval Weapons Center, China Lake, CA, 1972)

- 6.7 G.J. Linford: Appl. Opt. **33**, 8333 (1994)
- 6.8 J.L. Emmet, A.L. Schawlow: J. Appl. Phys. **35**, 2601 (1964)
- 6.9 J.R. Oliver, F.S. Barnes: Proc. IEEE **59**, 638 (1971)
- 6.10 J.H. Goncz, P.B. Newell: J. Opt. Soc. Am. **56**, 87 (1966)
- 6.11 J.H. Goncz: J. Appl. Phys. **36**, 742 (1965)
- 6.12 J.P. Markiewicz, J.L. Emmett: IEEE J. Quantum Electron. **QE-2**, 707 (1966)
- 6.13 J.F. Holzrichter, J.L. Emmett: Appl. Opt. **8**, 1459 (1969)
- 6.14 D.E. Perlman: Rev. Sci. Instr. **37**, 340 (1966)
- 6.15 K.R. Lang, F.S. Barnes: J. Appl. Phys. **35**, 107 (1964)
- 6.16 J.H. Rosolowski, R.J. Charles: J. Appl. Phys. **36**, 1792 (1965)
- 6.17 R.A. Dugdale, R.C. McVickers, S.D. Ford: J. Nuclear Mater. **12**, 1 (1964)
- 6.18 H.E. Edgerton, J.H. Goncz, J. Jameson: Xenon flashlamps, limits of operation. Proc. 6th Int'l Congr. on High Speed Photography, Haarlem, Netherlands (1963) p. 143
- 6.19 L. Waszak: Microwaves **130** (May 1969)
- 6.20 EG&G Linear Xeonon Flash Tubes, Data Sheet 1002-B
- 6.21 F. Schuda: In *Flashlamp-Pumped Laser Technology*, SPIE Proc. Vol. **609**, ed. by F. Schuda (SPIE, Bellingham, WA, 1986) p. 177
- 6.22 B. Newell, J.D. O'Brian: IEEE J. Quantum Electron. **QE-4**, 291 (1968)
- 6.23 J.F. Holzrichter, N. Dobeck, A. Pemberton: Flashlamp development, Laser Progr. Ann. Rept. UCRL-50021-74 (Lawrence Livermore Lab., 1974) pp. 107-115
- 6.24 L. Richter, F. Schuda, J. Degnan: In *Solid State Lasers*, SPIE Proc. Vol. 1223, ed. by G. Dubé (SPIE, Bellingham, WA, 1990) p. 142
- 6.25 W. Koehner, L. DeBenedictis, E. Matovich, G.E. Mevers: IEEE J. Quantum Electron. **QE-8**, 310 (1972)
- 6.26 J. Richards, D. Rees, K. Fueleop, B.A. See: Appl. Opt. **22**, 1325 (1983)
- 6.27 J.H. Kelly, D.C. Brown, K. Teegarden: Appl. Opt. **19**, 3817 (1980)
- 6.28 K. Yoshida, Y. Kato, H. Yoshida, C. Yamanaka: Rev. Sci. Instr. **55**, 1415 (1984)
- 6.29 G.N. Glascoe, J.V. Lebacqz: *Pulse Generators* (McGraw-Hill, New York, 1948)
- 6.30 J.R. Unternahrer: Private Communication (1994)
- 6.31 N.P. DePratti: J. Phys. E. **4**, 1 (1971)
- 6.32 V.J. Corcoran, R.W. McMillan, S.K. Barnoske: IEEE J. Quantum Electron. **QE-10**, 618 (1974)
- 6.33 F. Benjamin: Electro-Optical System Designs, **32** (March 1975)
- 6.34 W.L. Gagnon, G. Allen: Power conditioning, Laser Progr. Ann. Rept. UCRL-50021-74, (Lawrence Livermore Lab., 1974)
- 6.35 R.H. Dishington, W.R. Hook, R.P. Hilberg: Appl. Opt. **13**, 2300 (1974)
- 6.36 W.R. Hook, R.H. Dishington, R.P. Hilberg: IEEE Trans. Electron Devices **ED-19**, 308 (1972)
- 6.37 T.B. Read: Appl. Phys. Lett. **9**, 342 (1966)
- 6.38 W. Koehner: Laser Focus **5**, 29 (1969)
- 6.39 M. Grasis, L. Reed: Long-life krypton arc lamp for pumping Nd:YAG lasers, Techn. Rept. AFAL-TR-73-156 (ILC Technologies, Sunnyvale, CA, 1973)
- 6.40 W.E. Thouret: Illum. Eng. **55**, 295 (1960)
- 6.41 S. Yoshikawa, K. Iwamoto, K. Washio: Appl. Opt. **10**, 1620 (1971)
- 6.42 L.M. Osterink, J.D. Foster: In *1969 IEEE Conf. on Laser Eng. Appl., Washington, DC*
- 6.43 W. Streifer, D.R. Scifres, G.L. Harnagel, D.F. Welch, J. Berger, M. Sakamoto: IEEE J. Quantum Electron. **QE-24**, 883 (1988)
- 6.44 T.Y. Fan, R.L. Byer: IEEE J. Quantum Electron. **24**, 895 (1988)
- 6.45 J.G. Endriz, M. Vakili, G.S. Browder, M. DeVito, J.M. Haden, G.L. Harnagel, W.E. Plano, M. Sakamoto, D.F. Welch, S. Willing, D.P. Worland, H.C. Yao: IEEE J. Quantum Electron. **QE-28**, 952 (1992)
- 6.46 A.A. Karpinski: Laser Focus World (October 1994) p. 155; and In *Nov. 1990 Annual Meeting OSA*, Boston Mass. Technical Digest, paper MK10
- 6.47 K.J. Linden, P.N. McDonnell: NASA Conf. Publ. **3249**, 233 (1993)

- 6.48 R. Beach, W.J. Benett, B.L. Freitas, D. Mundinger, B.J. Comaskey, R.W. Solarz, M.A. Emanuel: IEEE J. Quantum Electron. **QE-28**, 966 (1992)
- 6.49 J.-H. Kim, R.J. Lang, A. Larson: Appl. Phys. Lett. **57**, 2048–2050 (1990)
- 6.50 N.W. Carlson, G. Evans, D. Bour, S. Liew: Appl. Phys. Lett. **56**, 16–18 (1990)
- 6.51 A. Scherer, J.L. Jewell, Y.H. Lee, J.P. Harbison, L.T. Florez: Appl. Phys. Lett. **55**, 2724 (1989)
- 6.52 M. Ettenberg: Laser Focus **22**, 86 (1985)
- 6.53 G. Harnagel, D. Welch, P. Cross, D. Scifers: 135 *Lasers Appl.* (June 1986)
- 6.54 K.A. Forrest, J.B. Abshire: IEEE J. Quantum Electron. **QE-23**, 1287 (1987)
- 6.55 E. Kapon: In *Handbook of Solid-State Lasers*, ed. by P.K. Cheo (Marcel Dekker, New York, 1989)
- 6.56 R. Burnham: Fibertek, Inc., private communication.
- 6.57 N.P. Barnes, M.E. Storm, P.L. Cross, M.W. Skolaut: IEEE J. Quantum Electron. **QE-26**, 558 (1990)
- 6.58 E.C. Honea, J.A. Skidmore, B.L. Freitas, E. Utterback, M.A. Emanuel: In *OSA Tops, Vol. 19, Adv. Solid State Lasers*, ed. by W.R. Rosenberg, M.M. Fejer (Opt. Soc. Am, 1998) p. 326
- 6.59 R.G. Waters, D.P. Bour, S.L. Yellen, N.F. Ruggieri: IEEE Photon. Technol. Lett. **2**, 531 (1990)
- 6.60 B. Li, G.L. Harnagel, R.R. Craig: Proc. SPIE **3285**, 93 (1998)
- 6.61 H. Asonen, J. Aarik, P. Bourmes, F. Corvini, M. Fang, M. Finander, M. Hmelar, R. Nabiev, J. Nappi, K. Rakennus, A. Salokatve: Proc. SPIE **3628**, 11 (1999)
- 6.62 G.C. Osbourn, P.L. Gourley, I.J. Fritz, R.M. Biefield, L.R. Dawson, T.E. Zipperian: In *Semiconductors and Semimetals, Vol. 24, Applications of Multiple Quantum Wells, Doping, and Superlattices*, ed. by R. Dingle (Academic, San Diego, CA, 1987) p. 459
- 6.63 R.G. Waters: In *LEOS'90*, Boston, 1990, paper SDL6.2
- 6.64 J.J. Coleman: In *LEOS'90*, Boston, 1990, paper SDL6.1
- 6.65 J.A. Skidmore, B.L. Freitas, J. Crawford, J. Satariano, E. Utterback, L. DiMercurio, K. Cutter, S. Sutton: Appl. Phys. Lett. **77**, 10 (2000)
- 6.66 J.L. Dallas, R.S. Afzal, M.A. Stephen: Appl. Opt. **35**, 1427 (1996)
- 6.67 D.A. Huchital: IEEE J. Quantum Electron. **QE-12** 1 (1976)
- 6.68 I.P. Lesnick, C.H. Church: IEEE J. Quantum Electron. **QE-2**, 16 (1966)
- 6.69 Yu.A. Kalinin: Sov. J. Opt. Techn. **37**, 1 (1970)
- 6.70 S.B. Schuldt, R.L. Aagard: Appl. Opt. **2**, 509 (1963)
- 6.71 C. Bowness: Appl. Opt. **4**, 103 (1965)
- 6.72 Yu.A. Kalinin, A.A. Mak: Opt. Tech. **37**, 129 (1970)
- 6.73 D.R. Skinner, J. Tregellas-Williams: Australian J. Phys. **19**, 1 (1966)
- 6.74 J. Whittle, D.R. Skinner: Appl. Opt. **5**, 1179 (1966)
- 6.75 D.R. Skinner: Appl. Opt. **8**, 1467 (1969)
- 6.76 W.R. Sooy, M.L. Stitch: J. Appl. Phys. **34**, 1719 (1963)
- 6.77 C.H. Cooke, J. McKenna, J.G. Skinner: Appl. Opt. **3**, 957 (1964)
- 6.78 D. Röss: *Lasers, Light Amplifiers and Oscillators* (Academic Press, New York, 1969) p. 426
- 6.79 H.U. Leuenberger, G. Herziger: Appl. Opt. **14**, 1190 (1975)
- 6.80 W. Koehner: Appl. Opt. **9**, 1429 (1970)
- 6.81 D.D. Bhawalkar, L. Pandit: IEEE J. Quantum Electron. **QE-9**, 43 (1973)
- 6.82 W.W. Morey: IEEE J. Quantum Electron. **QE-8**, 818 (1972)
- 6.83 A.N. Fletcher: Appl. Phys. B **37**, 31 (1985)
- 6.84 W.B. Jones: Laser Focus/Electro-Optic (September 1983) p. 107
- 6.85 W. Koehner, H. Verdun: Laser-diode array pumped solid state laser systems, Final Rept., (Naval Ocean Systems Command, Contract No. N00014-85-C-0174, 1986)
- 6.86 H. Bruesselbach, D.S. Sumida, R. Reeder, R.W. Byren: In *OSA TOPS, Vol. 10, Adv. Solid State Lasers*, ed. by C.R. Pollock, W.R. Bosenberg (Opt. Soc. Am., 1997) p. 285
- 6.87 R. Wu, P.B. Phua, K.S. Lai: Appl. Opt. **39**, 431 (2000)
- 6.88 J.J. Chang, E.P. Dragon, C.A. Ebberts, I.L. Bass, C.W. Cochran: In *OSA TOPS Vol. 19, Adv. Solid State Lasers*, ed. by W.R. Bosenberg, M.M. Fejer (Opt. Soc. Am., 1998) p. 300
- 6.89 N. Pavel, Y. Hirano, S. Yamamoto, Y. Koyata, T. Tajime: Appl. Opt. **39**, 986 (2000)

- 6.90 S. Lee, S.K. Kim, M. Yun, H.S. Kim, B.H. Cha, H.-J. Moon: Appl. Opt. **41**, 1089 (2002)
- 6.91 T.S. Rutherford, W.M. Tulloch, E.K. Gustafson, R.L. Byer: IEEE J. Quantum Electron. **QE-36**, 205 (2000)
- 6.92 A.D. Hays, G. Witt, N. Martin, D. DiBiase, R. Burnham: In *UV and Visible Lasers and Laser Crystal Growth*, Proc., SPIE, Vol. 2380 ed. by R. Scheps, M.R. Kokta (SPIE, Bellingham, WA, 1995) p. 88
- 6.93 R. Burnham, G. Moule, J. Unternahrer, M. McLaughlin, M. Kukla, M. Rhoades, D. DiBiase, W. Koechner: In *Laser'95*, Munich 1995, Paper K9.
- 6.94 J.R. Lee, H.J. Baker, G.J. Friel, G.J. Hilton, D.R. Hall: Opt. Lett. **27**, 524 (2002)
- 6.95 J.E. Bernard, A.J. Alcock: Opt. Lett. **19**, 1861 (1994); and **18**, 968 (1993)
- 6.96 J. Richards, A. McInnes: Opt. Lett. **20**, 371 (1995)
- 6.97 C.E. Hamilton, R.J. Beach, S.B. Sutton, L.H. Furu, W.F. Krupke: Opt. Lett. **19**, 1627 (1994)
- 6.98 A.J. Alcock, J.E. Bernard: IEEE J. Select. Topics Quantum Electron. **3**, 3 (1997)
- 6.99 W. Zendzian, J.K. Jabczynski, Z. Mierczyk: In *ICM Int. Congress Center Muenchen*, June 1999, Postdeadline paper NPD2-1
- 6.100 A.J. Alcock, J.E. Bernard: U.S. patent number 5,315,612
- 6.101 D.G. Hall, R.J. Smith, R.R. Rice: Appl. Opt. **19**, 3041 (1980)
- 6.102 T.Y. Fan, R.L. Byer: IEEE J. Quantum Electron. **23**, 605 (1987)
- 6.103 T.Y. Fan, A. Sanchez: IEEE J. Quantum Electron. **26**, 311 (1990)
- 6.104 P. Laporta, M. Brussard: IEEE J. Quantum Electron. **27**, 2319 (1991)
- 6.105 Y.E. Chen, T.S. Liao, C.F. Kao, T.M. Huang, K.H. Lin, S.C. Wang: IEEE J. Quantum Electron. **32**, 2010 (1996)
- 6.106 Y.F. Chen, C.F. Kao, S.C. Wang: Opt. Commun. **133**, 517 (1997)
- 6.107 N. Pavel, T. Taira: Opt. Eng. **38**, 1806 (1999)
- 6.108 Y.F. Chen, C.F. Kao, T.M. Huang, C.L. Wang, S.C. Wang: IEEE J. Select. Topics Quantum Electron. **3**, 29 (1997)
- 6.109 Y.F. Chen, T.M. Huang, C.F. Kao, C.L. Wang, S.C. Wang: IEEE J. Quantum Electron. **33**, 1424 (1997)
- 6.110 A. Brignon, G. Feugnet, J.P. Huignard, J.P. Pocholle: IEEE J. Quantum Electron. **QE-34**, 577 (1998)
- 6.111 C. Rahlff, M.H. Dunn, B.D. Sinclair, W. Sibbett: In CLEO'94, Anaheim, CA. 1994, p. **308**, Paper CThG4
- 6.112 W.A. Clarkson, D.C. Hanna: Opt. Lett. **21**, 869 (1996)
- 6.113 H.R. Verdun, T. Chuang: Opt. Lett. **17**, 1000 (1992)
- 6.114 E.C. Holnea, C.A. Ebberts, R.J. Beach, J.A. Speth, J.A. Skidmore, M.A. Emanuel, S.A. Payne: Opt. Lett. **23**, 1203 (1998)
- 6.115 G.F. Albrecht, J.M. Eggleston, J.J. Ewing: IEEE J. Quantum Electron. **QE-22**, 2099 (1986)
- 6.116 J.M. Eggleston, G.F. Albrecht, R.A. Petr, J.F. Zumdick: IEEE J. Quantum Electron. **QE-22**, 2092 (1986)
- 6.117 M.R. Siegrist: Appl. Opt. **15**, 2167 (1976)
- 6.118 J. Trenholme: Optimizing the design of a kilojoule laser amplifier chain, Laser Fusion Program, Semiannual Report (Lawrence Livermore Laboratory, 1973) p. 60.
- 6.119 Datasheet, *Jenoptik Laser*, Jena, Germany.
- 6.120 S. Erhard, A. Giesen, M. Karszewski, T. Rupp, C. Stewen, I. Johannsen, K. Contag: In *Proc. OSA Trends in Optics and Photonics, Adv. Solid State Lasers*, Washington, DC, 1999

Chapter 7

- 7.1 D.C. Brown: IEEE J. Quantum Electron. **34**, 560 (1998)
- 7.2 D.P. Devor, L.G. Shazer, R.C. Pastor: IEEE J. Quantum Electron. **25**, 1863 (1989)
- 7.3 B. Comaskey, B.D. Moran, G.F. Albrecht, R.J. Beach: IEEE J. Quantum Electron. **QE-31**, 1261 (1995)

- 7.4 T.Y. Fan: IEEE J. Quantum Electron. **QE-29**, 1457 (1993)
- 7.5 T.S. Chen, V.L. Anderson, O. Kahan: IEEE J. Quantum Electron. **QE-26**, 6 (1990)
- 7.6 M.S. Mangir, D.A. Rockwell: IEEE J. Quantum Electron. **QE-22**, 574 (1986)
- 7.7 D.S. Sumida, D.A. Rockwell, M.S. Mangir: IEEE J. Quantum Electron. **QE-24**, 985 (1988)
- 7.8 H.S. Carslaw, J.C. Jaeger: *Conduction of Heat in Solids* (Oxford University Press, London, 1948) p. 191
- 7.9 W. Koechner: Appl. Opt. **9**, 1429 (1970)
- 7.10 S.T. Hsu: *Engineering Heat Transfer* (Van Nostrand, Princeton, NJ, 1963) p. 274
- 7.11 G.D. Baldwin, E.P. Riedel: J. Appl. Phys. **38**, 2726 (1967)
- 7.12 M.K. Chun, J.T. Bischoff: IEEE J. Quantum Electron. **QE-7**, 200 (1971)
- 7.13 K.R. Richter, W. Koechner: Appl. Phys. **3**, 205 (1974)
- 7.14 W. Koechner: J. Appl. Phys. **44**, 3162 (1973)
- 7.15 B.A. Ermakov, A.V. Lukin: Sov. Phys. **15**, 1097 (1971)
- 7.16 S. Timoshenko, J.N. Goodier: *Theory of Elasticity*, 3rd ed. (McGraw-Hill, Singapore, 1982)
- 7.17 W. Koechner: Appl. Phys. **2**, 279 (1973)
- 7.18 M. Born, E. Wolf: *Principles of Optics* (Pergamon, London, 1965)
- 7.19 J.F. Nye: *Physical Properties of Crystals* (Clarendon, Oxford, UK, 1985), reprinted 1993
- 7.20 J.D. Foster, L.M. Osterink: J. Appl. Phys. **41**, 3656 (1970)
- 7.21 W. Koechner and D.K. Rice: IEEE J. Quantum Electron. **QE-6**, 557 (1970)
- 7.22 W. Koechner: Appl. Opt. **9**, 2548 (1970)
- 7.23 G.D. Baldwin: Q-switched evaluation of Nd:CaLaSOAP. Final Report AFAL-TR-72-334, Air Force Avionics Laboratory, Wright-Patterson AFB, Ohio (September 1972)
- 7.24 S.Z. Kurtev, O.E. Denchev, S.D. Savov: Appl. Opt. **32**, 278 (1993)
- 7.25 S. Jackel, I. Moshe, R. Lullouz: In *OSA Adv. Solid State Lasers*, Coeur d'Alene, ID, 1998, Tech. Digest, p. 127
- 7.26 J.J. Kasinski, R.L. Burnham: Appl. Opt. **35**, 5949 (1996)
- 7.27 Y. Hirano, Y. Koyata, S. Yamamoto, K. Kasahara, T. Tajime: Opt. Lett. **24**, 679 (1999)
- 7.28 J.M. Eggleston: IEEE J. Quantum Electron. **24**, 1821 (1988)
- 7.29 R. Byren: Hughes Aircraft Corp. Electro-Optical and Data Systems Group, private communication, 1991
- 7.30 S. Jackel, I. Moshe, R. Lallouz: In *OSA TOPS. Vol. 19: Advanced Solid-State Lasers*, ed. by W.R. Bosenberg, M.M. Fejer (Opt. Soc. Am., Washington, DC, 1998) p. 384
- 7.31 Q. Lü, N. Kugler, H. Weber, S. Dong, N. Müller, U. Wittrock: Opt. Quantum Electron. **28**, 57 (1996)
- 7.32 N. Kugler, S. Dong, Q. Lü, H. Weber: Appl. Opt. **36**, 9359 (1997)
- 7.33 J. Sherman: Appl. Opt. **37**, 7789 (1998)
- 7.34 J. Richards: Appl. Opt. **26**, 2514 (1987)
- 7.35 J.M. Eggleston, T.J. Kane, K. Kuhn, J. Unternahrer, R.L. Byer: IEEE J. Quantum Electron. **QE-20**, 289 (1984)
- 7.36 H.J. Baker, A. Chesworth, D.P. Millas, D.R. Hall: In *OSA TOPS. Vol. 19: Advanced Solid-State Lasers*, ed. by W.R. Bosenberg, M.M. Fejer (Opt. Soc. Am., Washington, DC, 1998) p. 407
- 7.37 J. Xu, J. Lee, H. Baker, D. Hall: In *Advanced Solid-State Photonics Topical Mtg.*, San Antonio, TX, February 2003, Postdeadline paper MB20-1
- 7.38 W.S. Martin, J.P. Chernoch: US Patent 3,633,126 (January 1972)
- 7.39 J.P. Chernoch, W.S. Martin, J.C. Almasi: Performance characteristics of a face-pumped, face-cooled laser, the mini-FPL. Tech. Rept. AFAL-TR-71-3, Air Force Avionics Lab., Wright Patterson AFB, OH, 1971
- 7.40 Lawrence Livermore National Lab., Medium Average Power Solid State Laser Technical Information Seminar, CA, October 1985
- 7.41 L.E. Zapata, K.R. Manes, D.J. Christie, J.M. Davin, J.A. Blink, J. Penland, R. Demaret, G. Dallum: Proc. Soc. Photo-Opt. Instrum. Eng. **1223**, 259 (1990)
- 7.42 N. Hodgson, S. Dong, Q. Lü: Opt. Lett. **18**, 1727 (1993); also in *CLEO'93* Baltimore, MD, paper CW16

- 7.43 R.J. Shine, A.J. Alfrey, R.L. Byer: *Opt. Lett.* **20**, 459 (1995)
- 7.44 W.B. Jones, L.M. Goldman, J.P. Chernoch, W.S. Martin: *IEEE J. Quantum Electron.* **QE-8**, 534 (1972); G.J. Hulme, W.B. Jones: Total internal reflection face pumped laser, *Proc. Soc., Photo-Optical Instr. Eng. IEEE J.* **QE-22**, 2092 (1986)
- 7.45 T. Kanabe, C. Yamanaka, N. Kitagawa, M. Takeda, M. Nakatsuka, S. Nakai: In *CLEO'92* (Anaheim, CA) paper CTUE5
- 7.46 A.D. Hays, G. Witt, N. Martin, D. DiBiase, R. Burnham: In *UV and Visible Lasers and Laser Crystal Growth*, SPIE Proc., Vol. 2380, ed. by R. Scheps, M.R. Kokta (1995) p. 88
- 7.47 R.S. Afzal, M.D. Selker: *Opt. Lett.* **20**, 465 (1995)
- 7.48 T.S. Rutherford, W.M. Tulloch, E.K. Gustafson, R.L. Byer: *IEEE J. Quantum Electron.* **36**, 205 (2000)
- 7.49 W.M. Tulloch, T.S. Rutherford, E.K. Gustafson, R.L. Byer: In *SPIE Vol. 3613: Solid-State Lasers VIII*, ed. by R. Scheps (SPIE, Wellingham, WA, 1999)
- 7.50 M. Nigel, R. Burnham: Fibertek Inc., private communication, 2004
- 7.51 Lawrence Livermore Laboratory Laser Program Annual Reports UCRL-520021 (1974–1998)
- 7.52 W.W. Simmons, D.R. Speck, L.J. Hunt: *Appl. Opt.* **17**, 999 (1978)
- 7.53 W.E. Martin, J.B. Trenholme, G.T. Linford, S.M. Yarema, C.A. Hurley: *IEEE J. Quantum Electrons.* **QE-17**, 1744 (1981)
- 7.54 D.C. Brown: In *High-Peak-Power Nd:Glass Laser Systems*, Springer Ser. Opt. Sci., Vol. 25 (Springer, Berlin Heidelberg, 1981)
- 7.55 M.A. Summers, J.B. Trenholme, W.L. Gagnon, R.J. Gelinas, S.E. Stokowski, J.E. Marion, H.L. Julien, J.A. Blink, D.A. Bender, M.O. Riley, R.F. Steinkraus: *High Power and Solid State Lasers*, SPIE Proc., Vol. 622, ed. by W. Simmons (1986) P. 2
- 7.56 J.C. Almasi, W.S. Martin: US Patent 3,631,362 (December 1971)
- 7.57 D.C. Brown, J.H. Kelly, J.A. Abate: *IEEE J. Quantum Electron.* **QE-17**, 1755 (1981)
- 7.58 J.A. Abate, L. Lund, D. Brown, S. Jacobs, S. Refermat, J. Kelly, M. Gavin, J. Waldbillig, O. Lewis: *Appl. Opt.* **20**, 351 (1981); also *Appl. Opt.* **20**, 1588 (1981)
- 7.59 J.H. Kelly, D.L. Smith, J.C. Lee, S.D. Jacobs, D.J. Smith, J.C. Lambropoulos: In *CLEO'87* (Baltimore, MD), Tech. Digest, p. 114
- 7.60 A. Giesen, M. Karszewski, C. Stewen, A. Voss, L. Berger, U. Brauch: In *Proc. Adv. Solid-State Lasers*, Vol. 24 (Opt. Soc. Am., Washington, DC, 1995) p. 330
- 7.61 Y. Liao, R.J.D. Miller, M.R. Armstrong: *Opt. Lett.* **24**, 1343 (1999)
- 7.62 J. Frauchiger, P. Albers, H.P. Weber: *IEEE J. Quantum Electron.* **QE-28**, 1046 (1992)
- 7.63 M.E. Innocenzi, H.T. Yura, C.L. Fincher, R.A. Fields: *Appl. Phys. Lett.* **56**, 1831 (1990)
- 7.64 S.C. Tidwell, J.F. Seamans, M.S. Bowers, A.K. Cousins: *IEEE J. Quantum Electron.* **QE-28**, 997 (1992)
- 7.65 U.O. Farrukh, A.M. Buoncristiani, E.C. Byvik: *IEEE J. Quantum Electron.* **24**, 2253 (1988)
- 7.66 S.B. Sutton, G.F. Albrecht: *Appl. Opt.* **32**, 5256 (1983)
- 7.67 A.K. Cousins: *IEEE J. Quantum Electron.* **QE-28**, 1057 (1992)
- 7.68 C. Pfistner, R. Weber, H.P. Weber, S. Merazzi, R. Gruber: *IEEE J. Quantum Electron.* **QE-30**, 1605 (1994)
- 7.69 R. Weber, B. Neuenschwander, M. MacDonald, M.B. Roos, H.P. Weber: *IEEE J. Quantum Electron.* **QE-34**, 1046 (1998)
- 7.70 H.C. Lee, P.L. Brownlie, H.E. Meissner, E.C. Rea: *SPIE Vol. 1624: Laser-Induced Damage in Optical Materials* (SPIE, Bellingham, WA, 1991) p. 2
- 7.71 B. Neuenschwander, R. Weber, H.P. Weber: *IEEE J. Quantum Electron.* **QE-31**, 1082 (1995)
- 7.72 X. Peng, A. Asundi, Y. Chen, Z. Xiong: *Appl. Opt.* **40**, 1396 (2001)
- 7.73 Y. Liao, R.J.D. Miller, M.R. Armstrong: *Opt. Lett.* **24**, 1343 (1999)
- 7.74 W.A. Clarkson, N.S. Felgate, D.C. Hanna: In *OSA TOPS. Vol.19: Advanced Solid-State Lasers*, ed. by W. Rosenberg, M.M. Feijer (Opt. Soc. Am., Washington, DC, 1998) p. 401
- 7.75 X. Peng, L. Xu, A. Asundi: *IEEE J. Quantum Electron.* **38**, 1291 (2002)
- 7.76 Y.F. Chen: *IEEE J. Quantum Electron.* **35**, 234 (1999)
- 7.77 J.L. Blows, T. Omatsu, J. Dawes, H. Pask, M. Tateda: *IEEE Photon. Technol. Lett.* **10**, 1727 (1998)

- 7.78 Y.F. Chen, H.J. Kuo: *Opt. Lett.* **23**, 846 (1998)
- 7.79 A. Sennaroglu: *Appl. Opt.* **38**, 3253 (1999)
- 7.80 Y.F. Chen, T.M. Huang, C.C. Liao, Y.P. Lan, S.C. Wang: *IEEE Photonics Technol. Lett.* **11**, 1241 (1999)
- 7.81 Y.F. Chen, Y.P. Lan, S.C. Wang: *Opt. Lett.* **25**, 1016 (2000)
- 7.82 M. Tsunekane, N. Taguchi, T. Kasamatsu, H. Inaba: *IEEE J. Select. Topics Quantum Electron.* **3**, 9 (1997)
- 7.83 E.A. Teppo: Nd:YAG laser technology. NWC Tech. Memo 2534, Appendix C (1975); and Tech. Note 4051-2 (1972), Naval Weapons Center, China Lake, CA
- 7.84 C.D. Marshall: *Proc. Advanced Solid State Laser Conf. (Opt. Soc. Am., Washington, D.C., 1996)*

Chapter 8

- 8.1 R.W. Hellwarth: In *Advances in Quantum Electronics* (Columbia Univ. Press, New York 1961) p. 334
- 8.2 F.J. McClung, R.W. Hellwarth: *Proc. IRE* **51**, 46 (1963)
- 8.3 W.G. Wagner, B.A. Lengyel: *J. Appl. Phys.* **34**, 2040 (1963)
- 8.4 J.J. Degnan: *IEEE J. Quantum Electron.* **QE-25**, 214 (1989)
- 8.5 J.E. Midwinter: *Brit. J. Appl. Phys.* **16**, 1125 (1965)
- 8.6 G.D. Baldwin: *IEEE J. Quantum Electron.* **QE-7**, 220 (1971)
- 8.7 R.B. Chesler, M.A. Karr, J.E. Geusic: *Proc. IEEE* **58**, 1899 (1970)
- 8.8 R.J. Collins, P. Kisliuk: *J. Appl. Phys.* **33**, 2009 (1962)
- 8.9 R.C. Benson, M.R. Mirarchi: *IEEE Trans. Mil. Electron.* **MIL-8**, 13 (1964)
- 8.10 W. Buchman, W. Koechner, D. Rice: *IEEE J. Quantum Electron.* **QE-6**, 747 (1970)
- 8.11 I.W. Mackintosh: *Appl. Opt.* **8**, 1991 (1969)
- 8.12 E.L. Steele, W.C. Davis, R.L. Treuthart: *Appl. Opt.* **5**, 5 (1966)
- 8.13 Kh.S. Bagdasarov, V.I. Zhekov, T.M. Murina, A.A. Manenkov, M.I. Timoshechkin, A.M. Prokhorov: *Sov. J. Quantum Electron.* **8**, 83 (1978)
- 8.14 Laser 1-2-3, Data Sheet, Schwartz Electro-Optics, Inc., Orlando, FL, 1997
- 8.15 F. Konz, M. Frenz, V. Romano, M. Forrer, H.P. Weber: *Opt. Commun.* **103**, 298 (1993)
- 8.16 H.J. Eichler, B. Liu, O. Sperlich: In *Solid State Lasers, Vol. VII* *Proc. SPIE*, Vol. 3265, ed. by R. Scheps, (SPIE Bellingham, WA, 1998) P. 75
- 8.17 R.O'B. Carpenter: *J. Opt. Soc. Am.* **40**, 225 (1950)
- 8.18 M. Born, E. Wolf: *Principles of Optics*, 2nd edn. (Macmillan, New York, 1964)
- 8.19 I.P. Kaminow, E.H. Turner: *Appl. Opt.* **54**, 1374 (1966)
- 8.20 F. Zernike Jr.: *J. Opt. Soc. Am.* **54**, 1215 (1964)
- 8.21 J.H. Ott, T.R. Sliker: *J. Opt. Soc. Am.* **54**, 1442 (1964)
- 8.22 M. Yamazaki, T. Ogawa: *J. Opt. Soc. Am.* **56**, 1407 (1966)
- 8.23 E.V. Raevesky, V.L. Pavlovitch: *Opt. Eng.* **38**, 1781 (1999)
- 8.24 S.Z. Kurtev, O.E. Denchev, S.D. Savov: *Appl. Opt.* **32**, 278 (1993)
- 8.25 P.V. Lenzo, E.G. Spencer, K. Nassau: *J. Opt. Soc. Am.* **56**, 633 (1966)
- 8.26 J.F. Ney: *Physical Properties of Crystals* (Oxford University Press, London, 1964)
- 8.27 M.J.P. Payne, H.W. Evans: In *CLEO'84*, Anaheim, CA, 1984, Techn. Digest, Paper TUB16
- 8.28 W.E. Schmid: *IEEE J. Quantum Electron.* **QE-16**, 790 (1980)
- 8.29 Kh. S. Bagdasarov, V.P. Danilov, L.A. Kulevskii, V.A. Lobachev, T.M. Murina A.M. Prokhorov: *Sov. J. Quantum Electron.* **10**, 1127 (1980)
- 8.30 E.A. Teppo: Nd:YAG Laser Lab. Experiments, January 1972 to June 1973, Technical Note 4051-7 (Naval Weapons Center, China Lake, CA, August 1973)
- 8.31 R.P. Hilberg, W.R. Hook: *Appl. Opt.* **9**, 1939 (1970)
- 8.32 T. Chuang, A.D. Hays, H.R. Verdun: *OSA Proc.: Adv. Solid State Lasers* **20**, 314 (1994); and *Appl. Opt.* **33**, 8355 (1994)
- 8.33 M.B. Rankin, G.D. Ferguson: *Proc. Soc. Photo-Opt. Instr. Eng.* **160**, 67 (1978)
- 8.34 J. Richards: *Appl. Opt.* **22**, 1306 (1983)

- 8.35 J. Richards: Appl. Opt. **26**, 2514 (1987)
- 8.36 E.A. Lundstrom: Waveplate for correcting thermally induced stress birefringence in solid state lasers, U.S. patent 4,408,334 (1983)
- 8.37 C.F. Quate, C.D. Wilkinson, D.K. Winslow: Proc. IEEE **53**, 1604 (1965)
- 8.38 N. Uchida, N. Niizeki: Proc. IEEE **61**, 1073 (1973)
- 8.39 R. Adler: IEEE Spect. **4**, 42 (1967)
- 8.40 R.W. Dixon: IEEE J. Quantum Electron. **QE-3**, 85 (1967)
- 8.41 R.W. Dixon: J. Appl. Phys. **38**, 5149 (1967)
- 8.42 P. Maak, L. Jakab, P. Richter, H.J. Eichler, B. Liu: Appl. Opt. **39**, 3054 (2000)
- 8.43 M. Hercher: Appl. Opt. **6**, 947 (1967)
- 8.44 Z. Burshtein, P. Blau, Y. Kalisky, Y. Shimony, M.R. Kokta: IEEE J. Quantum Electron. **QE-34**, 2292 (1998)
- 8.45 Y.-S. Choi: Appl. Opt. **40**, 5417 (2001)
- 8.46 Y. Shimony, Z. Burshtein, Y. Kalisky: IEEE J. Quantum Electron. **QE-31**, 1738 (1995)
- 8.47 J.J. Degnan: IEEE J. Quantum Electron. **QE-31**, 1890 (1995)
- 8.48 G. Xiao, M. Bass: IEEE J. Quantum Electron. **QE-33**, 41 (1997); and **QE-34**, 1142 (1998)
- 8.49 X. Zhang, S. Zhao, Q. Wang, Q. Zhang, L. Sun, S. Zhang: IEEE J. Quantum Electron. **QE-33**, 2286 (1997)
- 8.50 A. Agnesi, S. Dell'Acqua, E. Piccinini, G. Reali, G. Piccinno: IEEE J. Quantum Electron. **QE-34**, 1480 (1998)
- 8.51 T. Dascalu, N. Pavel, V. Lupei, G. Philipps, T. Beck, H. Weber: Opt. Eng. **35**, 1247 (May 1996)
- 8.52 A.D. Hays, R. Burnham: *Trends in Optics and Photonics*, Vol. 10, (Opt. Soc. Am., Washington, DC, 1997) P. 129
- 8.53 J.A. Morris, C.R. Pollock: Opt. Lett. **15**, 440 (1990)
- 8.54 J.J. Zayhowski, C. Dill: Opt. Lett. **19**, 1427 (1994)
- 8.55 J.J. Zayhowski, J. Ochoa, C. Dill: In *CLEO* 1995, P. 139, paper CTuM2
- 8.56 P. Wang, S.H. Zhou, K.K. Lee, Y.C. Chen: Opt. Commun. **114**, 439 (1995)
- 8.57 R. Wu, S. Hamlin, J.A. Hutchinson, L.T. Marshall: *Trends in Optics and Photonics*, Vol. 10, (Opt. Soc. Am., Washington, DC, 1997) P. 145
- 8.58 R.D. Stultz, M.B. Camargo, M. Lawler, D. Rockafellow, M. Birnbaum: In *OSA Advanced Solid State Lasers Conference*, Coeur d'Alene, ID, 1998, p. 330
- 8.59 Y.K. Kuo, Y.A. Chang: Appl. Opt. **42**, 1685 (2003)
- 8.60 B. Braun, F.X. Kaertner, G. Zhang, M. Moser, U. Keller: Opt. Lett. **22**, 381 (1997)
- 8.61 D. Maydan, R.B. Chesler: J. Appl. Phys. **42**, 1031 (1971)
- 8.62 R.B. Chesler, D. Maydan: J. Appl. Phys. **42**, 1028 (1971)
- 8.63 H.A. Kruegle, L. Klein: Appl. Opt. **15**, 466 (1976)
- 8.64 A. Hays: Fibertek, Inc., Private communication (1991)
- 8.65 J. Trenholme: Extraction of Energy from Laser Amplifiers. Laser Program Annual Report (1986) Chap. 7, Report UCRL 50021-86

Chapter 9

- 9.1 R. Bracewell: *The Fourier Transform and Its Applications* (McGraw-Hill, New York, 1965)
- 9.2 H.A. Haus, J.G. Fujimoto, E.P. Ippen: IEEE J. Quantum Electron. **QE-28**, 2086 (1992)
- 9.3 F. Krausz, M.E. Fermann, T. Brabec, P.F. Curley, M. Hofer, M.H. Ober, C. Spielmann, E. Wintner, A.J. Schmidt: IEEE J. Quantum Electron. **QE-28**, 2097 (1992)
- 9.4 W.T. Silfvast: *Laser Fundamentals* (Cambridge Univ. Press, Great Britain, 1996)
- 9.5 S.L. Shapiro (ed.): *Ultrashort Light Pulses*, Topics Appl. Phys., Vol. 18 (Springer, Berlin Heidelberg, 1977)
- 9.6 W. Kaiser (ed.): *Ultrashort Laser Pulses*, 2nd edn., Topics Appl. Phys., Vol. 60 (Springer, Berlin Heidelberg, 1993)

- 9.7 J.A. Fleck: *Phys. Rev. B* **1**, 84 (1970)
- 9.8 L.F. Mollenauer, R.H. Stolen: *Opt. Lett.* **9**, 13 (1984)
- 9.9 J. Goodberlet, J. Wang, J.G. Fujimoto, P.A. Schulz: *Opt. Lett.* **14**, 1125 (1989)
- 9.10 R.E. Bridges, R.W. Boyd, G.P. Agrawal: *Optics Lett.* **18**, 2026 (1993)
- 9.11 G. Cerullo, S. De Silvestri, V. Magni, O. Svelto: *Opt. Lett.* **19**, 1040 (1994), CLEO'94 (Anaheim, CA) paper CWA5 Tech. Digest p. 182
- 9.12 V. Magni, G. Cerullo, S. DeSilvestri: *Opt. Commun.* **101**, 365 (1993)
- 9.13 V. Magni, G. Cerullo, S. DeSilvestri: *Opt. Commun.* **96**, 348 (1993)
- 9.14 G. Cerullo, S. DeSilvestri, V. Magni, L. Pallaro: *Opt. Lett.* **19**, 807 (1994)
- 9.15 D.K. Negus, L. Spinelli, N. Goldblatt, G. Feuget: *OSA Proc. Adv. Solid-State Lasers* **10**, 120 (1991)
- 9.16 F. Krausz, C. Spielmann, T. Brabec, E. Wintner, A.J. Schmidt: *Opt. Lett.* **15**, 1082 (1990)
- 9.17 H.A. Haus, E.P. Ippen: *Opt. Lett.* **16**, 1331 (1991)
- 9.18 F. Salin, J. Squier, G. Mourou, M. Piché, N. McCarthy: *OSA Proc. Adv. Solid-State Lasers* **10**, 125 (1991)
- 9.19 D.E. Spence, P.N. Kean, W. Sibbett: *Opt. Lett.* **16**, 42–44 (1991)
- 9.20 D. Huang, M. Ulman, L.H. Acioli, H.A. Haus, J.G. Fujimoto: *Opt. Lett.* **17**, 511 (1992)
- 9.21 F. Salin, J. Squier, M. Piché: *Opt. Lett.* **16**, 1674 (1991)
- 9.22 M. Piché: *Opt. Commun.* **86**, 156 (1991)
- 9.23 T. Brabec, C. Spielmann, P.F. Curley, F. Krausz: *Opt. Lett.* **17**, 1292 (1992)
- 9.24 T. Brabec, P.F. Curley, C. Spielmann, E. Wintner, A.J. Schmidt: *J. Opt. Soc. Am. B* **10**, 1029 (1993)
- 9.25 U. Keller, D.A.B. Miller, G.D. Boyd, T.H. Chiu, J.F. Ferguson, M.T. Asom: *Opt. Lett.* **17**, 505 (1992); and In *OSA Proc. Adv. Solid State Lasers, Vol. 13*, L.L. Chase, A.A. Pinto (eds). (Opt. Soc. Am., pp. 98–100, 1992)
- 9.26 U. Keller, K.J. Weingaten, F.X. Kärtner, D. Kopf, B. Braun, I.D. Jung, R. Fluk, C. Hönninger, N. Matuschek, J. Aue de Au: *IEEE Select. Topics Quantum Electron.* **2**, 435 (1996)
- 9.27 I.D. Jung, F.X. Kärtner, N. Matuschek, D.H. Sutter, F. Morier-Genoud, G. Zhang, U. Keller: *Opt. Lett.* **22**, 1009 (1997)
- 9.28 G.J. Spühler, R. Paschotta, U. Keller, M. Moser, M.J.P. Dymott, D. Kopf, J. Meyer, K.J. Weingarten, J.D. Kmetec, J. Alexander, G. Truong: *Opt. Lett.* **24**, 528 (1999)
- 9.29 J.M. Hopkins, G.J. Valentine, B. Agate, A.J. Kemp, U. Keller, W. Sibbett, *IEEE J. Quantum Electron.* **38**, 360, (2002)
- 9.30 I.D. Jung, F.X. Kärtner, N. Matuschek, D.H. Sutter, F. Morier-Genoud, Z. Shi, V. Scheuer, M. Tilsch, T. Tschudi, U. Keller: *Appl. Phys. B* **65**, 137 (1997)
- 9.31 J.L. Dallas: *Appl. Opt.* **33**, 6373 (1994)
- 9.32 D.J. Kuizenga, A.E. Siegman: *IEEE J. Quantum Electron.* **QE-6**, 694–709 (1970)
- 9.33 A.E. Siegman, D.J. Kuizenga: *Appl. Phys. Lett.* **14**, 181 (1969)
- 9.34 A.E. Siegman, D.J. Kuizenga: *Opto-Electr.* **6**, 43 (1974)
- 9.35 C.J. Flood, D.R. Walker, H.M. van Driel: *Opt. Lett.* **20**, 58 (1995)
- 9.36 D.J. Kuizenga, D.W. Phillion, T. Lund, A.E. Siegman: *Opt. Commun.* **9**, 221 (1973)
- 9.37 D.J. Kuizenga: *IEEE J. Quantum Electron.* **QE-17**, 1694 (1981)
- 9.38 A. Hays, L.R. Marshall, J.J. Kasinski, R. Burnham: *IEEE J. Quantum Electron.* **QE-28**, 1021 (1992)
- 9.39 R.P. Johnson, N.K. Moncur, L.D. Siebert: In *CLEO'87*, Baltimore, MD, 1987, paper FP2
- 9.40 T. Sizer, I.N. Duling: *IEEE J. Quantum Electron.* **QE-24**, 404 (1988)
- 9.41 G.T. Maker, A.I. Ferguson: *Appl. Phys. Lett.* **54**, 403 (1989); and *Electron. Lett.* **25**, 1025 (1989)
- 9.42 U. Keller, K.D. Li, B.T. Khuri-Yakub, D.M. Bloom, K.J. Weingarten, D.C. Gerstenberger: *Opt. Lett.* **15**, 45 (1990)
- 9.43 L. Turi, C. Kuti, F. Krausz: *IEEE J. Quantum Electron.* **QE-26**, 1234 (1990)
- 9.44 F. Krausz, L. Turi, C. Kuti, A.J. Schmidt: *Appl. Phys. Lett.* **56**, 1415 (1990)
- 9.45 S.J. Walker, H. Avramopoulos, T. Sizer II: *Opt. Lett.* **15**, 1070 (1990)
- 9.46 J.H. Boyden: *Microwaves* **58** (March 1971)

- 9.47 G.T. Maker, A.I. Ferguson: *Opt. Lett.* **14**, 788 (1989)
- 9.48 T. Juhasz, S.T. Lai, M.A. Pessot: *Opt. Lett.* **15**, 1458 (1990)
- 9.49 G.P.A. Malcolm, J. Ebrahimzadeh, A.I. Ferguson: *IEEE J. Quantum Electron.* **QE-28**, 1172 (1992)
- 9.50 D.W. Hughes, M.W. Phillips, J.R.M. Barr, D.C. Hanna: *IEEE J. Quantum Electron.* **QE-28**, 1010 (1992)
- 9.51 F. Krausz, T. Brabec, E. Wintner, A.J. Schmidt: *Appl. Phys. Lett.* **55**, 2386 (1989)
- 9.52 R.L. Fork, O.E. Martinez, J.P. Gordon: *Opt. Lett.* **9**, 150 (1984)
- 9.53 J.P. Gordon, R.L. Fork: *Opt. Lett.* **9**, 153 (1984)
- 9.54 R. Szipocs, K. Ferencz, C. Spielmann, F. Krausz: *Opt. Lett.* **19**, 201 (1994)
- 9.55 F.X. Kaertner, N. Matuschek, T. Schibli, U. Keller, H.A. Haus, C. Heine, R. Morf, V. Scheuer, M. Tilsch, T. Tschudi: *Opt. Lett.* **22**, 831 (1997)
- 9.56 H.A. Haus, J.G. Fujimoto, E.P. Ippen: *J. Opt. Soc. Am. B* **8**, 2068 (1991)
- 9.57 C. Spielmann, F. Krausz, T. Brabec, E. Wintner, A.J. Schmidt: *Opt. Lett.* **16**, 1180 (1991)
- 9.58 U. Morgner, F.X. Kaertner, S.H. Cho, Y. Chen, H.A. Haus, J.G. Fujimoto, E.P. Ippen, V. Scheuer, G. Angelow, T. Tschudi: *Opt. Lett.* **24**, 411 (1999)
- 9.59 D.H. Sutter, G. Steinmeyer, L. Gallmann, N. Matuschek, F. Morier-Genoud, U. Keller, V. Scheuer, G. Angelow, T. Tschudi: *Opt. Lett.* **24**, 631 (1999)
- 9.60 Femtolasers Produktions GmbH, Vienna, Austria
- 9.61 P.R. Staver, W.T. Lotshaw: *OSA Proc. Adv. Solid-State Lasers* **20**, 252 (1994)
- 9.62 Y.M. Liu, P.R. Prucnal: *IEEE J. Quantum Electron.* **QE-29**, 2663 (1993)
- 9.63 M.T. Asaki, C.P. Huang, D. Garvery, J. Zhou, H.C. Kapteyn, M.M. Murnane: *Opt. Lett.* **18**, 977 (1993)
- 9.64 P.M. Mellish, P.M.W. French, J.R. Taylor, P.J. Delfyett, L.T. Florez: *Electron. Lett.* **30**, 223 (1994)
- 9.65 D. Kopf, K.J. Weingarten, L.R. Brovelli, M. Kamp, and U. Keller, in *Conference on Lasers and Electro-Optics*, Vol. 15 of 1995 OSA Technical Digest Series (Optical Society of America, Washington, DC 1995), p. 252, paper CWM2
- 9.66 M. J. P. Dymott, A.I. Ferguson: *Opt. Lett.* **19**, 1988 (1994)
- 9.67 D. Kopf, K.J. Weingarten, G. Zhang, M. Moser, M.A. Emanuel, R.J. Beach, J.A. Skidmore, U. Keller: *Appl. Phys. B-Lasers and Opt.* **65**, 235–243 (1997)
- 9.68 D. Kopf, A. Prasad, G. Zhang, M. Moser, U. Keller: *Opt. Lett.* **22**, 621–623 (1997)
- 9.69 S. Uemura, K. Torizuka: *IEEE J. Quantum Electron.* **39**, 68 (2003)
- 9.70 J.M. Hopkins, G.J. Valentine, B. Agate, A.J. Kemp, U. Keller, W. Sibbett: *IEEE J. Quantum Electron.* **38**, 360 (2002)
- 9.71 A. Seas, V. Petričević, R.R. Alfano: *Opt. Lett.* **17**, 937 (1992)
- 9.72 A. Sennaroglu, C.R. Pollock, H. Nathel: *Opt. Lett.* **18**, 826 (1993)
- 9.73 Y. Pang, V. Yanovsky, F. Wise, B.I. Minkov: *Opt. Lett.* **18**, 1168 (1993)
- 9.74 V. Yanovsky, Y. Pang, F. Wise, B.I. Minkov: *Opt. Lett.* **18**, 1541 (1993)
- 9.75 A. Seas, V. Petričević, R.R. Alfano: *Opt. Lett.* **18**, 891 (1993)
- 9.76 E. Innerhofer, T. Suedmeyer, F. Brunner, R. Haering, A. Aschwanden, R. Paschotta, U. Keller, C. Hoenninger, M. Kumkar: In *Advanced Solid-State Photonics Topical Mtg.* San Antonio, TX, Feb. 2003, p. 376
- 9.77 D. Strickland, G. Mourou: *Opt. Commun.* **56**, 219 (1985)
- 9.78 G.A. Mourou, C.P.J. Barty, M.D. Perry: *Phys. Today* **51**, 22 (Jan. 1998)
- 9.79 K. Yamakawa, M. Aoyama, S. Matsuoka, H. Takuma, C.P.J. Barty, D. Fittinghoff: *Opt. Lett.* **23**, 525 (1998)
- 9.80 C.P.J. Barty, T. Guo, C. Le Blanc, F. Raksi, C. Rose-Petruck, J. Squire, K.R. Wilson, V.V. Yakovlev, K. Yamakawa: *Opt. Lett.* **21**, 668 (1996)
- 9.81 P.A. Beaud, M. Richardson, E.J. Miesak: *IEEE J. Quantum Electron.* **QE-31**, 317 (1995)
- 9.82 P. Beaud, M. Richardson, E.J. Miesak, B. Chai: *Opt. Lett.* **18**, 1550 (1993)
- 9.83 A. Sullivan, H. Hamster, H.C. Kapteyn, S. Gordon, W. White, H. Nathel, R.J. Blair, R.W. Falcone: *Opt. Lett.* **16**, 1406 (1991)

Chapter 10

- 10.1 P.A. Franken, A.E. Hill, C.W. Peters, G. Weinreich: *Phys. Rev. Lett.* **7**, 118 (1961)
- 10.2 N. Bloembergen: *Nonlinear Optics* (Benjamin, New York), 4th printing.
- 10.3 F. Zernike, J.E. Midwinter: *Applied Nonlinear Optics* (Wiley, New York, 1973)
- 10.4 R.L. Sutherland: *Handbook of Nonlinear Optics* (Dekker, New York, 1973)
- 10.5 R.W. Boyd: *Nonlinear Optics* (Academic, San Diego, CA, 1992)
- 10.6 Y.R. Shen: *The Principles of Nonlinear Optics* (Wiley, New York, 1984)
- 10.7 D.A. Kleinman: In *Laser Handbook*, ed. by F.T. Arecchi, E.O. Schulz-DuBois, Vol. 2 (North-Holland, Amsterdam, 1972), pp. 1229–1258
- 10.8 J.A. Armstrong, N. Bloembergen, N. Ducuing, P.S. Pershan: *Phys. Rev.* **127**, 1918 (1962)
- 10.9 A. Yariv, P. Yeh: *Optical Waves in Crystals* (Wiley, New York, 1984)
- 10.10 D. Eimerl: *IEEE J. Quantum Electron.* **QE-23**, 575 (1987); and **QE-23**, 1361 (1981)
- 10.11 M.V. Hobden: *J. Appl. Phys.* **38**, 4365 (1967)
- 10.12 M. Born, E. Wolf: *Principles of Optics* (Macmillan, New York, 1964)
- 10.13 F.D. Bloss: *Crystallography and Crystal Chemistry* (Holt, Rinehart, Winston, New York, 1971)
- 10.14 N.F. Nye: *Physical Properties of Crystals* (Clarendon, Oxford, 1964)
- 10.15 Lasermetrics, Electro-Optics Div., Englewood Cliffs, NJ, Data Sheet 8701; In *Optical Harmonic Generating Crystals*, February 1987
- 10.16 R.C. Eckardt, H. Masuda, Y.X. Fan, R.L. Byer: *IEEE J. Quantum Electron.* **QE-26**, 922 (1990)
- 10.17 G.D. Boyd, A. Ashkin, J.M. Dzielic, D.A. Kleinman: *Phys. Rev.* **137**, A1305 (1965)
- 10.18 A.V. Smith, D.J. Armstrong, W.J. Alford: *J. Opt. Soc., B* **15**, 122 (1998)
- 10.19 R.S. Craxton, S.D. Jacobs, J.E. Rizzo, R. Boni: *IEEE J. Quantum Electron.* **QE-17**, 1762 (1981)
- 10.20 R.P. Jones: In *Solid-State Lasers and Nonlinear Crystals*, SPIE Proc., Vol. 2379, ed. G.J. Quarks, L. Esterowitz, L.K. Cheng (SPIE, Wellingham, WA, 1995) p. 357
- 10.21 J.C. Jacco, G.M. Loiacono: Final Report under contract DAAK20-83-C-0139 Night Vision and Electronics Lab. Fort Belvoir, VA 22060, 1986
- 10.22 J.D. Bierlein: *SPIE Proc.* **1104**, 2 (1989)
- 10.23 L.K. Cheng, L.T. Chen, J.D. Bierlein, F.C. Zumsteg, A.A. Ballman: *Appl. Phys. Lett.* **62**, 346 (1993)
- 10.24 R. Wu: *Appl. Opt.* **32**, 971 (1993)
- 10.25 S. Zhao, C. Huang, H. Zhang: *J. Cryst. Growth* **99**, 805 (1990)
- 10.26 S. Lin, Z. Sun, B. Wu, C. Chen: *J. Appl. Phys.* **67**, 634 (1990)
- 10.27 K. Kato: *IEEE J. Quantum Electron.* **QE-22**, 1013 (1986)
- 10.28 W.J. Kozlovsky, C.D. Nabors, R.L. Byer: *IEEE J. Quantum Electron.* **QE-24**, 913 (1988)
- 10.29 R. Ono, T. Kamimura, S. Fukumoto, Y. Yap, M. Yoshimura, Y. Mori, T. Sasaki, K. Yoshida: *J. Cryst. Growth* **237**, 645 (2002)
- 10.30 H. Kitano, M. Matsui, K. Sato, N. Ushiyama, M. Yoshimura, Y. Mori, T. Sasaki: *Opt. Lett.* **28**, 263 (2003)
- 10.31 T. Sakuma, K. Deki, A. Finch, Y. Ohsako, T. Yokota: *App. Opt.* **39**, 5505 (2000)
- 10.32 T. Kojima, S. Konno, S. Fujikawa, K. Yasui, K. Yoshizawa: *Opt. Lett.* **25**, 58 (2000); also In *OSA TOPS, Vol. 68: Advanced Solid-State Lasers*, ed. by M.E. Fermann, L.R. Marshall (Opt. Soc. Am., Washington, DC, 2002) p. 464
- 10.33 U. Stamm, W. Zschocke, T. Schroeder, N. Deutsch, D. Basting: In *OSA TOPS, Vol. 10: Advanced Solid-State Lasers*, ed. by C.R. Pollock, W.R. Bosenberg (Opt. Soc. Am., Washington, DC, 1997)
- 10.34 D.C. Gerstenberger, T.M. Trautmann, M.S. Bowers: *Opt. Lett.* **28**, 1242 (2003)
- 10.35 P. Dekker, J. Dawes, P. Burns, J. Piper: In *OSA TOPS, Vol. 68: Advanced Solid-State Lasers*, ed. by M.E. Fermann, L.R. Marshall (Opt. Soc. Am., Washington, DC, 2002) p. 41
- 10.36 M. Yarborough, J. Falk, C.B. Hitz: *Appl. Phys. Lett.* **18**, 70 (1971)
- 10.37 B.J. Le Garrec, G.J. Raze, P.Y. Thro, M. Gilbert: *Opt. Lett.* **21**, 1990 (1996)
- 10.38 M.V. Ortiz, J.H. Fair, D.J. Kuizenga: In *OSA Proc. Adv. Solid State Lasers*, Vol. 13, (Opt. Soc. Am., Washington, DC, 1992) p. 361

- 10.39 R.G. Smith: IEEE J. Quantum Electron. **QE-6**, 215 (1970)
- 10.40 J.E. Geusic, H.J. Levinstein, S. Singh, R.G. Smith, L.G. van Uitert: Appl. Phys. Lett. **12**, 306 (1968)
- 10.41 T. Baer: J. Opt. Soc. Am., B **3**, 1175 (1986)
- 10.42 D.W. Anthon, D.L. Sipes, T.J. Pier, M.R. Ressler: IEEE J. Quantum Electron. **28**, 1148 (1992)
- 10.43 H. Nagai, M. Kume, I. Ohta, H. Shimizu, M. Kazumura: IEEE J. Quantum Electron. **28**, 1164 (1992)
- 10.44 Y.F. Chen, T.M. Huang, C.L. Wang, L.J. Lee: Appl. Opt. **37**, 5727 (1998)
- 10.45 M. Oka, S. Kubota: Opt. Lett. **13**, 805 (1988)
- 10.46 G.E. James, E.M. Harrell, C. Bracikowski, K. Wiesenfeld, R. Roy: Opt. Lett. **15**, 1141 (1990)
- 10.47 V. Magni, G. Cerullo, S. DeSilvestri, O. Svelto, L.J. Qian, M. Danailov: Opt. Lett. **18**, 2111 (1993)
- 10.48 J.J. Chang, E.P. Dragon, C.A. Ebberts, I.L. Bass, C.W. Cochran: In *OSA Adv. Solid-State Lasers*, February, 2–4, 1998, post deadline paper pd 15-1
- 10.49 E.C. Honea, C.A. Ebberts, R.J. Beach, J.A. Speth, J.A. Skidmore, M.A. Emanuel, S.A. Payne: Opt. Lett. **23**, 1203 (1998)
- 10.50 J.E. Murray, S.E. Harris: J. Appl. Phys. **41**, 609 (1970)
- 10.51 O. Bernecker: IEEE J. Quantum Electron. **QE-9**, 897 (1973)
- 10.52 J. Falk: IEEE J. Quantum Electron. **QE-11**, 21 (1975)
- 10.53 W. Seka, S.D. Jacobs, J.E. Rizzo, R. Boni, R.S. Craxton: Opt. Commun. **34**, 469–473 (1980)
- 10.54 R.S. Craxton: IEEE J. Quantum Electron. **QE-17**, 1771 (1981); Opt. Commun. **34**, 474 (1980)
- 10.55 A.D. Hays, L.R. Marshall, R. Burnham: In *Advanced Solid-State Lasers* (Hilton Head, SC) (OSA, Washington, DC, 1991), postdeadline paper PdP8
- 10.56 H. Hemmati, J.R. Lesh: Opt. Lett. **19**, 1322 (1994)
- 10.57 J. Kasinski, P. Bournes, D. DiBiase, R. Burnham: In *CLEO'93*, Baltimore, MD, paper CW11; *Tech. Digest Ser.* **11**, 274 (OSA, Washington, DC, 1993)
- 10.58 G.J. Linford, B.C. Johnson, J.S. Hildum, W.E. Martin, K. Snyder, R.D. Boyd, W.L. Smith, C.L. Vercimak, D. Eimerl, J.T. Hunt: Appl. Opt. **21**, 3633 (1982)
- 10.59 J.A. Giordmaine, R.C. Miller: Phys. Rev. Lett. **14**, 973 (1965)
- 10.60 R.G. Smith: In *Laser Handbook I*, ed. by F.T. Arecchi, E.O. Schultz-DuBois (North-Holland, Amsterdam, 1972) pp. 837–895; also *Lasers*, Vol. 4, ed. by A.K. Levine, A.J. De Maria (Dekker, New York, 1976) pp. 189–307
- 10.61 S.J. Brosnan, R.L. Byer: IEEE J. Quantum Electron. **QE-15**, 415–443 (1979)
- 10.62 R.L. Byer: In *Quantum Electronics: A Treatise*, Vol. I, Pt. B, ed. by H. Rabin, C.L. Tang (Academic, New York, 1973) pp. 587–702
- 10.63 G.D. Boyd, A. Ashkin: Phys. Rev. **146**, 198 (1966)
- 10.64 L.R. Marshall, A.D. Hays, J.J. Kasinski, R. Burnham: In *Adv. Solid-State Lasers*, Salt Lake City, UT (OSA Washington, DC, March 1990), postdeadline paper WC8PD-2
- 10.65 J.J. Kasinski, R. Burnham: In *CLEO'90* (Anaheim, CA), Dig. Tech. Papers, paper CMF5
- 10.66 L.R. Marshall, A.D. Hays, R. Burnham: In *CLEO'90* (Anaheim, CA), Dig. Tech. Paper, post-deadline paper CPDP35-1
- 10.67 Castech-Phoenix, Inc., Fuzhou, China, Data Sheet KTP
- 10.68 J.E. Bjorkholm: IEEE J. Quantum Electron. **QE-7**, 109 (1971)
- 10.69 M.J.T. Milton, T.D. Gardiner, G. Chourdakakis, P.T. Woods: Opt. Lett. **19**, 281 (1994)
- 10.70 R.L. Burnham: Final Report Solid-State Mid Infrared Source. Contract: DAAB07-87-C-F074, Fibertek, Inc., 1998
- 10.71 J. Yao, W. Sheng, W. Shi: J. Opt. Soc. Am., B **9**, 891 (1992)
- 10.72 J.W. Yao, T.S. Fahlen: J. Appl. Phys. **55**, 65 (1984)
- 10.73 K. Kato: IEEE J. Quantum Electron. **QE-27**, 1137 (1991)
- 10.74 D. Eimerl: J. Appl. Phys. **62**, 1968 (1987)
- 10.75 C.L. Tang, W.R. Bosenberg, T. Ukachi, R. Lane, L. Cheng: Laser Focus World, (Oct. 1990) p. 107

- 10.76 K. Kato: IEEE J. Quantum Electron. **QE-27**, 1137 (1991)
- 10.77 J.T. Lin, J.L. Montgomery: Opt. Commun. **75**, 315–320 (1990)
- 10.78 R. Burnham, R.A. Stolzenberger, A. Pinto: IEEE Photon. Technol. Lett. **1**, 27–28 (1989)
- 10.79 R.P. Jones: In *Solid-State Lasers and Nonlinear Crystals*, SPIE Proc., Vol. 2379 ed. by G.J. Quarks, L. Esterowitz, L.K. Cheng, (1995) p. 357
- 10.80 W.R. Bosenberg, L.K. Cheng, J.D. Bierlein: In *Adv. Solid-State Lasers and Compact Blue-Green Lasers*, New Orleans, LA, Vol. 2 (OSA, Washington, DC, 1993) pp. 134–135
- 10.81 T. Chuang, J. Kasinski, H.R. Verdun: In *TOPS on Advanced Solid State Lasers*, Vol. 1, (OSA, Washington, DC, 1996) p. 150
- 10.82 S. Chandra, T.H. Allik, J.A. Hutchinson, R. Utano, G. Catella: In *TOPS Advanced Solid State Lasers*, Vol. 10, (OSA, Washington, DC, 1997) p. 270
- 10.83 S. Chandra, T.H. Allik, G. Catella, J.A. Hutchinson: In *Advanced Solid-State Lasers*, Coeur d'Alene, ID (OSA, Washington, DC, 1998) p. 102, paper AMD5-1
- 10.84 M.M. Fejer, G.A. Magel, D.H. Jundt, R.L. Byer: IEEE J. Quantum Electron. **QE-28**, 2631 (1992)
- 10.85 L.E. Myers, R.C. Eckardt, M.M. Fejer, R.L. Byer: J. Opt. Soc. Am., B **12**, 2102 (1995)
- 10.86 L.E. Myers, W.R. Bosenberg: IEEE J. Quantum Electron. **QE-33**, 1663 (1997)
- 10.87 D.H. Jundt: Opt. Lett. **22**, 1553 (1997)
- 10.88 L.E. Myers, W.R. Bosenberg, J.I. Alexander, M.A. Arbore, M.M. Fejer, R.L. Byer: In *Advanced Solid State Laser Conference*, San Francisco (OSA, Washington, DC, 1996), postdeadline paper PD5-1
- 10.89 W.R. Bosenberg, A. Drobshoff, L.E. Meyers: In *Advanced Solid State Laser Conference*, San Francisco (OSA, Washington, DC, 1996), Tech. Digest, p. 68, paper WD1-1
- 10.90 T. Chuang, R. Burnham: Opt. Lett. **23**, 43 (1998)
- 10.91 T. Chuang, R. Burnham: In *Advanced Solid-State Laser Conference*, Boston, MA (OSA, Washington, DC, 1999), Tech. Digest, p. 118, paper ME3-1
- 10.92 K.C. Burr, C.L. Tang: Opt. Lett. **22**, 1458 (1997)
- 10.93 T.P. Grayson, L.E. Myers, M.D. Nelson, V. Dominic: In *Advanced Solid State Laser Conference*, San Francisco, CA 1996 (OSA, Washington, DC), Tech. Digest, p. 71, paper WD2-1
- 10.94 G.D. Miller, R.G. Batchko, W.M. Tulloch, D.R. Weise, M.M. Fejer, R.L. Byer: Opt. Lett. **22**, 1834 (1997)
- 10.95 M. Taya, M.C. Bashaw, M.M. Fejer: Opt. Lett. **21**, 857 (1996)
- 10.96 Y. Furukawa, K. Kitamura, S. Takekawa, K. Niwa, H. Hatano: Opt. Lett. **23**, 1892 (1998)
- 10.97 J.P. Meyn, M.M. Fejer: Opt. Lett. **22**, 1214 (1997)
- 10.98 M.E. Klein, D.H. Lee, J.P. Meyn, B. Beier, K.J. Boller, R. Wallenstein: Opt. Lett. **23**, 831 (1998)
- 10.99 T. Kartaloglu, K.G. Köprülü, O. Aytür, M. Sundheimer, W.P. Risk: Opt. Lett. **23**, 61 (1998)
- 10.100 V. Pasiskevicius, S. Wang, H. Karlsson, J.A. Tellefsen, F. Laurell: In *Advanced Solid-State Lasers*, Coeur d'Alene, ID (OSA, Washington, DC, 1998) p. 183
- 10.101 T. Chang, R. Burnham: In *OSA TOPS Adv. Solid-State Lasers*, ed. by M.M. Fejer, H. Injeyan, U. Keller Vol. 26, (1999) p. 534
- 10.102 R. Dabu, A. Stratan, C. Fenic, C. Luculescu, L. Muscalu: Opt. Eng. **40**, 455 (2001)
- 10.103 P.B. Phua, K.S. Lai, R. Wu: Appl. Opt. **39**, 1435 (2000)
- 10.104 K.L. Vodopyanov, P.G. Schunemann: Opt. Lett. **28**, 441 (2003)
- 10.105 P.A. Budni, C.R. Ibach, S.D. Setzler, L.A. Pomeranz, M.L. Lemons, P.A. Ketteridge, E.J. Gustafson, Y.E. Young, P.G. Schunemann, T.M. Pollak, R.T. Castro, E.P. Chicklis: In *Adv. Solid-State Photonics*, February 2003, postdeadline paper PD12
- 10.106 M.J. Roskar, C.L. Tang: J. Opt. Soc. Am., B **2**, 691 (1985)
- 10.107 T.Y. Fan, R.C. Eckardt, R.L. Byer, J. Nolting, R. Wallenstein: Appl. Phys. Lett. **53**, 2014 (1988)
- 10.108 A. Fix, C. Huang, T. Shroder, R. Wallenstein: In *CLEO'90*, Anaheim, CA, Tech. Digest, p. 248, paper CWE8
- 10.109 J.G. Haub, M.J. Johnson, B.J. Orr, R. Wallenstein: In *CLEO'91*, Baltimore, MD, Tech. Digest, paper CFM1
- 10.110 W.L. Bosenberg, L.K. Cheng, C.L. Tang: Appl. Phys. Lett. **54**, 13 (1989)
- 10.111 L.R. Marshall, A. Kaz, O. Aytur: Opt. Lett. **18**, 817 (1993)

- 10.112 M.E. Klein, C.K. Laue, D.H. Lee, K.J. Boller, R. Wallenstein: *Opt. Lett.* **25**, 490 (2000)
- 10.113 U. Stroessner, J.P. Meyn, R. Wallenstein, P. Urenski, A. Arie, G. Rosenman, J. Mlynek, S. Schiller, A. Peters: *J. Opt. Soc. Am.* **19**, 1419 (2002)
- 10.114 W.R. Bosenberg, J.I. Alexander, L.E. Myers, R.W. Wallace: *Opt. Lett.* **23**, 207 (1998)
- 10.115 W.R. Bosenberg, A. Drobshoff, J.I. Alexander, L.E. Myers, R.L. Byer: *Opt. Lett.* **21**, 1336 (1996)
- 10.116 D.J.M. Stothard, M. Ebrahimzadeh, M.H. Dunn: *Opt. Lett.* **23**, 1895 (1998)
- 10.117 U. Stroessner, A. Peters, J. Mlynek, S. Schiller, J.P. Meyn, R. Wallenstein: *Opt. Lett.* **24**, 1602 (1999)
- 10.118 T.J. Edwards, G.A. Turnbull, M.H. Dunn, M. Ebrahimzadeh, H. Karlsson, G. Aridsson, F. Laurell: *Opt. Lett.* **23**, 837 (1998)
- 10.119 C.W. Hoyt, M. Sheik-Bahae, M. Ebrahimzadeh: *Opt. Lett.* **27**, 1543 (2002)
- 10.120 R.L. Byer: Frequency conversion via stimulated Raman scattering. *Electro-Optical Systems Design*, February 1980, pp. 24–29
- 10.121 Y.R. Shen: Stimulated Raman scattering, in *Topics Appl. Phys., Vol. 8: Light Scattering in Solids I*, Vol 2nd edn., ed. by M. Cardona, (Springer, Berlin Heidelberg, 1983) Chap.7
- 10.122 G.L. Eesley: *Coherent Raman Spectroscopy* (Pergamon, New York, 1981); A. Owyong: In *Chemical Applications of Nonlinear Raman Spectroscopy*, ed. by B. Harvey (Academic, New York, 1981) pp. 281–320
- 10.123 W. Kaiser, M. Maier: In *Laser Handbook*, Vol. II, ed. by F.T. Arecchi, E.O. Schulz-DuBois (North-Holland, Amsterdam, 1972)
- 10.124 F.P. Milanovich: In *Handbook of Laser Science and Technology*, Vol. 3, ed. by M.J. Weber (CRC, Boca Raton, FL, 1986) p. 283
- 10.125 H.M. Pask, S. Myers, J.A. Piper, J. Richards, T. McKay: *Opt. Lett.* **28**, 435 (2003)
- 10.126 H.M. Pask, J.A. Piper: *Opt. Lett.* **24**, 1490 (1999)
- 10.127 P. Cerny, H. Jelinkova: *Opt. Lett.* **27**, 360 (2002)
- 10.128 H. Ogilvy, H. Pask, J. Piper, T. Omatsu: paper MB11-1. In *Tech. Digest Adv. Solid-State Photonics*, 2003 San Antonio, Texas (Opt. Soc. Am. Washington, D.C. 2003)
- 10.129 D.G. Bruns, D.A. Rockwell: High energy Raman resonator. Hughes Aircraft Comp. Culver City, CA, Final Report, Report FR-81-72-1035, 1981
- 10.130 B.Ya. Zel'dovich, Y.I. Popovichev, V.V. Ragul'skii, F.S. Faizullov: *Sov. Phys. JETP* **15**, 109 (1972)
- 10.131 O.Yu Nosach, V.I. Popovichev, V.V. Ragul'skii, F.S. Faizullov: *JETP Lett.* **16**, 435 (1972)
- 10.132 D.T. Hon: *Opt. Eng.* **21**, 252–256 (1982)
- 10.133 I.D. Carr, D.C. Hanna: *Appl. Phys. B* **36**, 83 (1985)
- 10.134 D.A. Rockwell: *IEEE J. Quantum Electron.* **QE-24**, 1124 (1988)
- 10.135 D.M. Pepper: *Opt. Eng.* **21**, 156–286 (1982), special issue on non-linear optical phase conjugation
- 10.136 R.A. Fisher (ed.): *Optical Phase Conjugation* (Academic, New York, 1983)
- 10.137 B.Ya. Zel'dovich, N.F. Pilipetsky, V.V. Shkunov: *Springer Ser. Opt. Sci., Vol. 42: Principles of Phase Conjugation* (Springer, Berlin Heidelberg, 1985)
- 10.138 D.M. Pepper: In *Laser Handbook*, Vol. 4, ed. by M.L. Stith, M. Bass (North-Holland, Amsterdam, 1985) pp. 333–485
- 10.139 N.F. Andreev, M.A. Dvoret'skii, A.A. Leshchev, V.G. Manishin, G.A. Pasmanik, T.P. Samarina: *Sov. J. Quantum Electron.* **15**, 928 (1985)
- 10.140 A. Kummrow, H. Meng: *Opt. Commun.* **83**, 342 (1991)
- 10.141 R. Menzel, H.J. Eichler: *Phys. Rev. A* **46**, 7139 (1992)
- 10.142 R. Menzel, D. Schulze: In *Proc. Int'l Summer School on Applications of Nonlinear Optics*, Prague, 1993
- 10.143 D. Cotter, D.C. Hanna, R. Wyatt: *Appl. Phys.* **8**, 333 (1975)
- 10.144 M. Maier, G. Renner: *Phys. Lett. A* **34**, 299–300 (1971)
- 10.145 H.J. Eichler, A. Haase, R. Menzel: *IEEE J. Quantum Electron.* **QE-31**, 1265 (1995)
- 10.146 H.J. Eichler, O. Mehl, J. Eichler: In *Conf. on Solid State Lasers VIII*, San Jose, CA, January 1999, SPIE. Proc., Vol. 3613 (1999) p. 166
- 10.147 V.N. Belousov, Yu.K. Nizienko: *Opt. Spectrosc. (USSR)* **58**, 563 (1985)

- 10.148 N.G. Basov, V.F. Efimkov, I.G. Zubarev, A.V. Kotov, S.I. Mikhailov, M.G. Smirnov: JETP Lett. **28**, 197 (1978)
- 10.149 H.J. Eichler, A. Haase, R. Menzel: In *Proc. Int'l Summer School and Top. Meeting on Applications on Nonlinear Optics*, Prague, 1993
- 10.150 J.J. Eichler, R. Menzel, D. Schumann: Appl. Opt. **31**, 5038 (1992)
- 10.151 M. Ostermeyer, A. Heuer, R. Menzel: IEEE J. Quantum Electron. **QE-34**, 372 (1998)

Chapter 11

- 11.1 Test method for the laser-radiation-induced damage threshold of optical surfaces. ISO 11254 (The International Organization for Standardization, 1992)
- 11.2 S.C. Seitel, A. Giesen, J. Becker: Proc. SPIE **1848**, 2 (1992)
- 11.3 J. Becker, A. Bernhardt: Proc. SPIE **2114**, 703 (1993)
- 11.4 *Laser-Induced Damage in Optical Materials* (1969–1989), National Bureau of Standards (National Institute of Standards and Technology after 1986), Special publication, ed. by H. E. Bennett, L.L. Chase, A.J. Glass, A.H. Guenther, D. Milam, B.E. Newman, M.J. Soileau
- 11.5 *Laser-Induced Damage in Optical Materials*: SPIE Proc. **1441** (1990), SPIE Proc. **1624** (1991), SPIE Proc. **1848** (1992), SPIE Proc. **2114** (1993), each ed. by H.E. Bennett, A.H. Guenther, L.O. Chase, B.E. Newnam, M.J. Soileau; SPIE Proc. **2428** (1994), SPIE Proc. **2714** (1995), SPIE Proc. **2966** (1996), ed. by H.E. Bennett, A.H. Guenther, M.R. Kozlowski, B.E. Newnam, M.J. Soileau; SPIE Proc. **3244** (1997), ed. by G.J. Exarhos, A.H. Guenther, M.R. Kozlowski, M.J. Soileau.
- 11.6 R.M. Wood (ed.): Selected papers on laser damage in optical materials. SPIE Milestone Series MS24, 1990
- 11.7 N. Bloembergen: Appl. Opt. **12**, 661 (1973)
- 11.8 N.L. Boling, G. Dubé: Appl. Phys. Lett. **23**, 658 (1973)
- 11.9 N. Bloembergen: IEEE J. Quantum Electron. **QE-10**, 375 (1974)
- 11.10 F.Y. Génin, A. Salleo, T.V. Pistor, L.L. Chase: J. Opt. Soc. Am. A **18**, 2607 (2001)
- 11.11 N.L. Boling, M.D. Crisp, G. Dubé: Appl. Opt. **12**, 650 (1973)
- 11.12 M.D. Crisp, N.L. Boling, G. Dubé: Appl. Phys. Lett. **21**, 364 (1972)
- 11.13 M.D. Feit, A.M. Rubenchick, D.R. Faux, R.A. Riddle, A. Shapiro, D.C. Eder, B.M. Penetrante, D. Milam, F.Y. Genin, M.R. Kozlowski: SPIE Proc. **2966**, 417 (1996)
- 11.14 R.W. Hopper, D.R. Uhlmann: J. Appl. Phys. **41**, 4023 (1970)
- 11.15 E.S. Bliss: Opto-electronics **3**, 99 (1971)
- 11.16 J.R. Bettis, R.A. House II, A.H. Guenther: Natl. Bur. Stand. (U.S.) Spec. Publ. **462**, 338 (1976)
- 11.17 R.M. Wood: *Laser Damage in Optical Materials* (Hilger, Boston, 1986)
- 11.18 J.H. Campbell, F. Rainer, M.R. Kozlowski, C.R. Wolfe, I.M. Thomas, F.P. Milanovich: Lawrence Livermore National Laboratory, ICF Quarterly Report (January–March 1991) p. 41
- 11.19 B.C. Stuart, M.D. Feit, S. Herman, A.M. Rubenchik, B.W. Shore, M.D. Perry: Phys. Rev. Lett. **74**, 2248 (1995)
- 11.20 B.C. Stuart, M.D. Feit, S. Herman, A.M. Rubenchik, B.W. Shore, M.D. Berry: Phys. Rev. B **53**, 1749 (1996)
- 11.21 B.C. Stuart, M.D. Perry, R.D. Boyd, J.A. Britten, B.W. Shore, M.D. Feit, A.M. Rubenchik: In *Generation, Amplification, and Measurement of Ultrashort Laser Pulses II*, SPIE Proc., Vol. 2377 ed. by F.W. Wise, C.P.J. Barty. (SPIE, Wellingham, WA, 1995) p. 247
- 11.22 S.C. Jones, P. Braunlich, R.T. Casper, X.A. Shen, P. Kelly: Opt. Eng. **28**, 1039 (1989)
- 11.23 F. Rainer, L.J. Atherton, J.T. DeYoreo: SPIE Proc. **1848**, 46 (1992)
- 11.24 N. Kuzuu, K. Yoshida, H. Yoshida, T. Kamimura, N. Kamisugi: Appl. Opt. **38**, 2510 (1999)
- 11.25 J.H. Campbell, F. Rainer: Report UCRL-JC-109255, Lawrence Livermore Laboratory, Livermore, CA; In *SPIE '92 Conf. Proc.*, San Diego, CA, 1992
- 11.26 G.Y. Kolodnyi, E.V. Levchuk, V.V. Novopashin, O.E. Sidoryuk: Laser Optoelektronik **28**, 61 (1996)
- 11.27 L. Sheehan, M. Kozlowski, F. Rainer, M. Staggs: SPIE Proc. **2114**, 559 (1994)

- 11.28 C.R. Wolfe, M.R. Kozlowski, J. Campbell, F. Rainer, A.J. Morgan, R.P. Gonzales: NIST (U.S.) Spec. Publ. **801**, 360 (1990)
- 11.29 M.R. Kozlowski, M. Staggs, F. Rainer, J. Stathis: SPIE Proc. **1441**, 269 (1991)
- 11.30 M.R. Kozlowski, I.M. Thomas, J.H. Campbell, R. Rainer: In *Thin Films for Optical Systems*, SPIE Proc., Vol. 1782 ed. by K.H. Guenther (SPIE, Wellingham, WA, 1992) p. 105
- 11.31 N. Kaiser, B. Anton, H. Jänchen, K. Mann, E. Eva, C. Fischer, R. Henking, D. Ristau, P. Weissbrodt, D. Mademann, L. Raupach, E. Hacker: SPIE Proc. **2428**, 400 (1994)
- 11.32 A. Fornier, C. Cordillot, D. Bernardino, D. Ausserre, F. Paris: SPIE Proc. **2714**, 383 (1995)
- 11.33 M. Richardson, M.J. Soileau, P. Beaud, R. DeSalvo, S. Garnov, D.J. Hagan, S. Klimentov, K. Richardson, M. Sheik-Bahae, A.A. Said, E. Van Stryland, B.H.T. Chai: SPIE Proc. **1848**, 392 (1992)
- 11.34 R.M. Wood, R.T. Taylor, R.L. Rouse: Opt. Laser Technol. **6**, 105 (1975)
- 11.35 T.S. Rose, M.S. Hopkins, R.A. Fields: IEEE J. Quantum Electron. **QE-31**, 1593 (1995)
- 11.36 N. Neuroth, R. Hasse, A. Knecht: NBS Spec. Publ. **356**, 3–14 (1971); In *Damage in Laser Materials*, ed. by A.J. Glass, A.H. Guenther Natl. Bur. Standards (U.S.)
- 11.37 K.E. Montgomery, F.P. Milanovich: J. Appl. Phys. **68**, 15 (1990)
- 11.38 F. Rainer, L.J. Atherton, J.H. Campbell, F.P. DeMarco, M.R. Kozlowski, A.J. Morgan, M.C. Staggs: SPIE Proc. **1624**, 116 (1991)
- 11.39 J. Chang, E. Dragon, C. Ebberts, I. Bass, C. Cochran: In *OSA Trends in Optics and Photonics, Vol. 19: Advanced Solid-State Lasers*, ed. by W.R. Bosenberg, M.M. Fejer (Opt. Soc. Am., Washington, DC, 1998) p. 300
- 11.40 R.P. Jones, A.M. Floener, J.S. Runkel: Presented at *26th Annual Boulder Damage Symposium*, 1994
- 11.41 R.P. Jones: In *Solid-State Lasers and Nonlinear Crystals*, SPIE Proc., Vol. 2379 ed. by G.J. Quarles, L. Esterowitz, Z.K. Cheng (SPIE, Wellingham, WA, 1995) p. 357
- 11.42 M.P. Sripsick, G.E. Ruland: *OSA TOPS, Vol. 19: Advanced Solid-State Lasers*, ed. by W.R. Bosenberg, M.M. Fejer (Opt. Soc. Am., Washington, DC, 1998) p. 85
- 11.43 L.E. Halliburton, M.P. Sripsick: SPIE Proc. **2379**, 235 (1995)
- 11.44 B. Boulanger, J.P. Fève, Y. Guillien: Opt. Lett. **25**, 484 (2000)
- 11.45 F.C. Zumsteg, J.D. Bierlein, E.E. Gier: J. Appl. Phys. **47**, 4980 (1976)
- 11.46 J.K. Tyminski: J. Appl. Phys. **70**, 5570 (1991)
- 11.47 J.C. Jacco, D.R. Rockafellow, E.A. Teppo: Opt. Lett. **16**, 1307 (1991)
- 11.48 M.P. Sripsick, D.N. Lolacono, J. Rottenberg, S.H. Goellner, L.E. Halliburton, F.K. Hopkins: Appl. Phys. Lett. **66**, 3428 (1995)
- 11.49 G.M. Laiacono, D.N. Laiacono, T. McGee, M. Babb: J. Appl. Phys. **72**, 2705 (1992)
- 11.50 J.P. Fève, B. Boulanger, G. Marnier, H. Albrecht: Appl. Phys. Lett. **70**, 277 (1997)
- 11.51 M.P. Sripsick, G.J. Edwards, L.E. Halliburton, R.F. Belt, G.M. Loiacono: J. Appl. Phys. **76**, 733 (1994)
- 11.52 B. Boulanger, M.M. Fejer, R. Blachman, P.F. Bordui: Appl. Phys. Lett. **65**, 2401 (1994)
- 11.53 P.A. Morris, A. Ferretti, M.G. Roeloffs, J.D. Bierlein, T.M. Baer: SPIE Proc. **1848**, 24 (1992)
- 11.54 W.D. Fountain, L.M. Osterink, G.A. Massey: In NBS Spec. Publ. **356**, 91–103 (1971); In *Damage in Laser Materials*, ed. by A.J. Glass, A.H. Guenther Natl. Bur. Standards (U.S.)
- 11.55 A.M. Glass: Opt. Eng. **17**, 470 (1978)
- 11.56 D.A. Bryan, R.R. Rice, R. Gerson, H.E. Tomaschke, K.L. Sweeney, L.E. Halliburton: Opt. Eng. **24**, 138–143 (1985)
- 11.57 V. Pruneri, P.G. Kazansky, J. Webjörn, P.St.J. Russell, D.C. Hanna: Appl. Phys. Lett. **67**, 1957 (1995)
- 11.58 G.A. Magel, M.M. Fejer, R.L. Byer: Appl. Phys. Lett. **56**, 108 (1990)
- 11.59 M. Taya, M.C. Bashaw, M.M. Fejer: Opt. Lett. **21**, 857 (1996)
- 11.60 M.A. Acharekar, L.H. Morton, E.W. Van Stryland: SPIE Proc. **2114**, 69 (1993)
- 11.61 S. Chandra, T.H. Allik, G. Catella, J.A. Hutchinson: In *Advanced Solid-State Laser Conf. 1998*, Coeur d'Alene, ID, p. 102
- 11.62 M.R. Kozlowski, R. Chow: SPIE Proc. **2114**, 640 (1993)

- 11.63 Q. Zhao, Z.X. Fan, H. Qiu, Y. Liu, Z.J. Wang: SPIE Proc. **2966**, 238 (1996)
- 11.64 B. Steiger, H. Brausse: SPIE Proc. **2428**, 559 (1994)
- 11.65 R.H. Sawicki, C.C. Shang, T.L. Swatloski: SPIE Proc. **2428**, 333 (1994)
- 11.66 A. Bodemann, N. Kaiser, M. Kozłowski, E. Pierce, C. Stolz: SPIE Proc. **2714**, 395 (1995)
- 11.67 I.M. Thomas: SPIE Proc. **2114**, 232 (1993)
- 11.68 N. Kaiser: Laser Optoelektronik **28**, 52 (1996)
- 11.69 C. Li, Z. Li, Y. Sun: SPIE Proc. **2114**, 280 (1993)
- 11.70 S.V. Garnov, S.M. Klimentov, A.A. Said, M.J. Soileau: SPIE Proc. **1848**, 162 (1992)
- 11.71 K.L. Lewis, A.M. Pitt, M. Corbett, R. Blacker, J. Simpson: SPIE Proc. **2966**, 166 (1996)
- 11.72 T.L. Barber: Rev. Sci. Instrum. **40**, 1630 (1969)
- 11.73 F.E. Hovis, B. Shepherd, C. Radcliffe, H. Maliborski: SPIE Proc. **2428**, 72 (1994)

Appendix A

- A.1 Courtesy; Coherent, Inc. Laser Group. 5100 Patrick Henry Drive, Santa Clara, CA
- A.2 American National Standards Institute, 11 West 42nd Street, New York, NY 10036
- A.3 D. Sliney, M. Wolbarsht: *Safety with Lasers and Other Optical Sources* (Plenum, New York, 1980)
- A.4 *LIA Laser Safety Guide*, Laser Institute of America, 12424 Research Parkway, Suite 125, Orlando, FL
- A.5 Center for Devices and Radiological Health (HFZ-300), 8757 Georgia Avenue, Silver Spring, MD 20910. Performance Standards for Laser Products, Regulation 21CFR1040 (latest revision, April 1993)
- A.6 International Electrotechnical Committee (IEC), Geneva, Switzerland. IEC Standard 825-1 (1993). Radiation Safety of Laser Products, Equipment Classifications, Requirements and User's Guide

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