

# Contents

List of Symbols .....	XIII
Introduction .....	XVII

---

## Part I Theoretical Background

---

1	Fundamentals of Solid-State Lasers .....	3
1.1	Energy-Level Diagram and Rate Equations .....	3
1.2	Amplifiers .....	6
1.3	Oscillator in the Stationary Case .....	9
1.4	Threshold and Losses .....	17
1.5	Influence of the Temperature .....	18
1.6	Oscillator in Pulsed Operation .....	20
1.7	Q-switch Operation .....	27
1.8	The 3-Level System .....	33
1.9	Efficiency and Optimization .....	38
2	Gaussian Optics .....	45
2.1	Gaussian Beam .....	45
2.2	Higher Order Modes .....	48
2.3	ABCD Law .....	54
2.4	Sign Conventions .....	58
2.5	Matrices of Optical Elements .....	60
2.6	Application of the ABCD Law .....	63
3	Resonators .....	69
3.1	Stable Resonators .....	70
3.2	Empty Resonators .....	74
3.3	Conventional Stable Resonators .....	77
3.4	Special Resonators with Two External Mirrors .....	83
3.5	Multicavity Resonators .....	88
3.6	Alignment Sensitivity of Stable Resonators .....	91
3.7	Unstable Resonators .....	95
4	Thermal Effects .....	99
4.1	Heat Efficiency .....	99
4.2	Temperature Profile .....	101
4.3	Transient Thermal Effects .....	104
4.4	Thermal Load .....	106
4.5	Influence on the Level Population .....	109

4.6	Thermal Lensing .....	110
4.7	Lens Effects in the Resonator .....	113
4.8	Experimental Determination of the Refracting Power ...	117
4.9	Thermally Invariant Resonators .....	119

---

## Part II Technical Realization

---

5	Beam Source .....	125
5.1	Pumping Cavity for Rods .....	126
5.2	Pumping Cavity for Slabs .....	133
5.3	Cooling .....	138
5.4	Cooling Unit .....	145
6	Gas Discharge Lamps .....	149
6.1	Ionization for Flash and Arc Lamps .....	150
6.2	Expansion of the Plasma Arc (Booster Circuit) .....	155
6.3	Voltage Current Characteristic .....	157
6.4	On- and Off-Switching Characteristics .....	161
6.5	Transient Progress .....	166
6.6	Lifetime .....	167
6.7	Spectral Characteristics .....	171
6.8	Radiation Characteristic .....	174
6.9	Recommendations for Operation .....	176
7	Excitation by Diodes .....	177
7.1	Concepts .....	177
7.2	Layout of the Laser Diodes .....	183
7.3	Semiconductor Materials .....	187
7.4	Technical Data of the Laser Diodes .....	190
7.5	Excitation of a Solid-State Laser .....	195
8	Electrical Circuits .....	199
8.1	Ignition Circuits .....	199
8.2	Power Supplies .....	201
8.3	Energy Storage .....	202
8.4	Power Modulation .....	207
9	Optics .....	209
9.1	Focusing Optics .....	209
9.2	Lens Aberrations .....	213
9.3	Scanning Systems .....	214
9.4	Beam Splitter .....	219
9.5	Beam Guiding by Fibers .....	220
9.6	Transformation of Constant Resonator Parameters .....	227
9.7	Laser-Induced Damage .....	231
10	Material Processing .....	233
10.1	Beam Parameters .....	235
10.2	Material Parameters .....	236

10.3	Application Parameters .....	238
10.4	Relations Between the Parameters .....	239
10.5	Measurement Procedures .....	251

---

## Part III Data and Specifications

---

11	Laser Materials .....	257
11.1	Parameter Specification .....	257
11.2	Active Ions .....	269
12	Laser Crystals .....	289
13	Laser Glasses .....	311
14	Material Data .....	319
14.1	Optical Transparent Media .....	319
14.2	Materials for Manufacturing .....	322
15	Tables and Constants .....	325
15.1	Conversion Tables .....	325
15.2	Special Conversions .....	326
15.3	Physical Constants .....	328
15.4	Mathematical Constants .....	328
<b>References .....</b>		<b>329</b>
<b>Index .....</b>		<b>347</b>

<http://www.springer.com/978-3-540-66980-7>

Solid-State Lasers for Materials Processing  
Fundamental Relations and Technical Realizations

Iffländer, R.

2001, XVII, 353 p., Hardcover

ISBN: 978-3-540-66980-7