

Contents

	<i>Preface</i>	<i>page xi</i>
1	Fundamentals of laser energy absorption	1
	1.1 Classical electromagnetic-theory concepts	1
	1.2 Optical properties of materials	21
	References	32
2	Lasers and optics	33
	2.1 Lasers for materials processing	33
	2.2 Some specific laser systems	36
	2.3 Basic principles of laser operation	39
	2.4 Definition of laser intensity and fluence variables	48
	2.5 Optical components	50
	2.6 Beam delivery	51
	References	57
3	Thermal processes in laser–materials interactions	60
	3.1 Macroscopic transport	60
	3.2 Conductive heat transfer	61
	3.3 Melting	72
	3.4 Ablative material removal	75
	References	84
4	Desorption at low laser energy densities	87
	4.1 Vapor kinetics	87
	4.2 Time-of-flight instruments	90
	4.3 Kinetic distributions of ejected particles	96
	References	107
5	Dynamics of laser ablation	109
	5.1 Introduction	109
	5.2 Laser-induced plasma formation	111

viii	Contents	
	5.3 Modeling of ablation-plume propagation	116
	5.4 Diagnostics of laser-ablated plumes	122
	5.5 Picosecond-laser plasmas	133
	References	141
6	Ultrafast-laser interactions with materials	146
	6.1 Introduction	146
	6.2 Femtosecond-laser interaction with metals	147
	6.3 Femtosecond-laser interaction with semiconductor materials	158
	6.4 Phase transformations induced by femtosecond laser irradiation	160
	6.5 Generation of highly energetic particles	168
	6.6 Ultrafast phase explosion	172
	6.7 Nonlinear absorption and breakdown in dielectric materials	176
	6.8 Application in the micromachining of glass	195
	References	196
7	Laser processing of thin semiconductor films	202
	7.1 Modeling of energy absorption and heat transfer in pulsed-laser irradiation of thin semitransparent films	202
	7.2 Continuous-wave (CW) laser annealing	203
	7.3 Inhomogeneous semiconductor-film melting	205
	7.4 Nanosecond-laser-induced temperature fields in melting and resolidification of silicon thin films	209
	7.5 Nucleation in the supercooled liquid	217
	7.6 Lateral crystal growth induced by spatially modified irradiation	222
	7.7 Mass transfer and shallow doping	231
	References	235
8	Laser-induced surface modification	240
	8.1 Hydrodynamic stability of transient melts	240
	8.2 Capillary-driven flow	245
	8.3 Glass-surface modification	256
	References	263
9	Laser processing of organic materials	265
	9.1 Introduction	265
	9.2 Fundamental processes	265
	9.3 Applications	273
	References	278

10	Pulsed-laser interaction with liquids	282
	10.1 Rapid vaporization of liquids on a pulsed-laser-heated surface	282
	10.2 Pulsed-laser interaction with absorbing liquids	292
	10.3 Nonlinear interaction of short-pulsed lasers with dielectric liquids	304
	References	309
11	Laser cleaning of particulate contaminants	313
	11.1 Introduction	313
	11.2 Adhesion forces	314
	11.3 A practical laser-cleaning system	319
	11.4 Mechanisms of laser cleaning	321
	References	328
12	Laser interactions with nanoparticles	330
	12.1 Size effects on optical properties	330
	12.2 Melting of nanoparticles	333
	12.3 Laser-induced production of nanoparticles	339
	References	348
13	Laser-assisted microprocessing	350
	13.1 Laser chemical vapor deposition	350
	13.2 Laser direct writing	355
	13.3 Laser microstereolithography	368
	References	374
14	Nano-structuring using pulsed laser radiation	376
	14.1 Introduction	376
	14.2 Apertureless NSOM nanomachining	377
	14.3 Apertured NSOM nanomachining	383
	14.4 Nanoscale melting and crystallization	386
	14.5 Laser-assisted NSOM chemical processing	389
	14.6 Plasmas formed by near-field laser ablation	392
	14.7 Outlook	396
	References	396
	<i>Index</i>	399