

# Contents

<b>1</b>	<b>Introduction</b> .....	1
<b>2</b>	<b>Light-Driven Ordering: Theory</b> .....	9
	2.1 Ordering in Molecular Crystals .....	10
	2.1.1 Spatial Ordering .....	10
	2.1.2 Orientational Ordering .....	16
	2.2 Ordering in Random Impurity System .....	19
<b>3</b>	<b>Domain Charge Structure of Amorphous Semiconductor</b> .....	29
	3.1 Light-Driven Electron–Hole Kinetics in Amorphous Media .....	29
	3.2 Investigations of Electron–Hole Correlation in Optical Experiments	37
<b>4</b>	<b>Light-Driven Spatial Ordering in Random Media</b> .....	45
	4.1 Motion Against a Force .....	45
	4.2 Light-Induced Bielectron .....	48
	4.3 Light-Induced Bunching of Electrons .....	51
	4.3.1 Optical Piston in Glasses .....	51
	4.3.2 Instability of Homogeneous Electron Distribution .....	56
	4.3.3 Visualization of the Domain Structure. Experimental .....	58
	4.3.4 Site-Selective Bond Breaking .....	66
	4.3.5 Light-Driven Self-Drilling in Glasses .....	69
	4.3.6 Discussion .....	74
<b>5</b>	<b>Light-Driven Orientational Ordering in Random Media</b> .....	77
	5.1 All Optical Poling of Glasses: Theory .....	77
	5.2 Preparation of $\chi^{(2)}$ Grating .....	84
	5.3 Phase-Matched Second Harmonic Generation: Experimental .....	85
	5.4 $1/\omega$ Fluctuation of the Induced Polarization and Doubling Efficiency	90
<b>6</b>	<b>Self-Organization in Ge-Doped Silica Fibers and Second Harmonic Generation</b> .....	95
	6.1 Breakdown of the Inversion Symmetry in the Ge-Doped Silica Fibers .....	95
	6.2 Charge Transfer Excitons (CTE) in Germanium Silicate Optical Fibers .....	97

6.3	Positive Feedback in Response to Static Electric Field . . . . .	105
6.3.1	Response of a Two-Level CTE System . . . . .	105
6.3.2	Response of a CTE System with Distant Electron Transfer . . . . .	110
6.3.3	Response of Localized Electrons and Holes . . . . .	112
6.4	Wave Propagation through a Ge-Doped Silica Optical Fiber . . . . .	118
6.4.1	Propagation of a Weak Second-Harmonic Wave . . . . .	118
6.4.2	Highly Efficient Second Harmonic Generation . . . . .	123
6.5	Comparison of the Theory with Experiments and the Results of Other Models . . . . .	128
<b>7</b>	<b>Optical Motor: Toward the Model of Life Emerging on Earth . . . . .</b>	<b>139</b>
7.1	Self-Organization Driven by Natural Light . . . . .	139
7.2	Self-Organization as Prebiotic Stage of Life Emergence . . . . .	141
7.3	Broadband Optical Piston . . . . .	142
7.4	Light-Driven Anti-Le Chatelier Behavior . . . . .	150
<b>8</b>	<b>Electron Acceleration by Petawatt Light Pulses . . . . .</b>	<b>155</b>
8.1	Relativistic Effects . . . . .	157
8.2	Nonlinearity of Vacuum . . . . .	158
<b>9</b>	<b>Light-Driven Temporal Self-Organization . . . . .</b>	<b>161</b>
9.1	Impurity Center under Strong Laser Field . . . . .	162
9.1.1	Self-Consistent Approach . . . . .	162
9.1.2	Exact Equations of Motion . . . . .	168
9.1.3	Illumination of a Light-Driven Impurity Center . . . . .	171
9.1.4	Solitons . . . . .	172
9.2	Nonlinear Electron–Phonon Oscillations at Resonance Condition . . . . .	175
9.2.1	Energy Exchange Between Impurity and a Lattice . . . . .	175
9.2.2	Excitation of Nonlinear Oscillation . . . . .	183
<b>10</b>	<b>Light-Driven Bistability of Molecular Crystals . . . . .</b>	<b>187</b>
10.1	Bistability and Jumps in Luminescence . . . . .	187
10.2	Computer Simulation of Bistability . . . . .	191
<b>11</b>	<b>Charge Transfer Excitons in Soft Matter . . . . .</b>	<b>199</b>
11.1	Mixing of CTE and Molecular Excitons . . . . .	199
11.2	CTEs in Low-Dimensional Structures . . . . .	201
11.2.1	Spectroscopy of CTEs in Quasi-One-Dimensional Structures . . . . .	207
11.2.2	CTE Self-Trapping in Soft Matter . . . . .	216
	<b>Discussion . . . . .</b>	<b>233</b>
	<b>References . . . . .</b>	<b>235</b>
	<b>Index . . . . .</b>	<b>239</b>