

Contents

Preface	V
List of Contributors	XI
Acknowledgements	XIII
Introduction	1
<hr/>	
Part 1. Creation of Induced Structures in Glasses	
<hr/>	
1. Ultrafast Induction of Electronic Structures by Ultrashort Laser Pulses	7
1.1 Introduction	7
1.2 Ultrafast Refractive Index Alteration in Glasses Containing Bi_2O_3	8
1.3 Third-Order Nonlinear Optical Properties of Chalcogenide Glasses	12
1.4 Refractive Index Change Induced by Femtosecond Laser Pulses in a Metallic Nanoparticle System	16
1.4.1 Historical Background	16
1.4.2 White-Light Pump-Probe Method and Transient Absorption Spectra	18
1.4.3 The Origin of the Nonlinear Response	21
1.4.4 Nonequilibrium Thermodynamics in the Metallic Nanoparticle System	25
1.4.5 The Origin of the Damping Constant in the Drude Term	28
1.5 Optical Switches Using Organic Solutions	30
1.6 Anomalous Anisotropic Light Scattering in Ge-Doped Silica Glass	34
2. Induction of Permanent Structures by Ultrashort Laser Pulses	41
2.1 Introduction	41

2.2	Induction of Permanent Structure with Femtosecond Laser Pulses and the Mechanism Utilized .	42
2.3	Photowritten Three-Dimensional Optical Waveguides	47
2.4	Three-Dimensional Control of Microcrystal Precipitation in Glass	53
2.5	Space-Selective Precipitation of Single Crystals with Nonlinear Optical Function Within Glass Using a Femtosecond Laser Irradiation	57
2.6	Optical Poling of Glasses	62
2.6.1	Historical Background	62
2.6.2	Photoinduced SHG in Germanosilicate Glasses Using a Femtosecond Laser	64
2.6.3	Band-Gap Dependence of Photoinduced SHG in Bi ₂ O ₃ - B ₂ O ₃ -SiO ₂ Glasses	68
2.7	Optical Poling of Dye-Doped Inorganic Glass for Second-Harmonic Generation	71
2.7.1	Historical Background	72
2.7.2	Thermosetting Enhancement of Photoinduced SHG Stability in Dye-Doped Glasses	73
2.7.3	Optical Poling of Azo-Dye-Doped Thin Films Using an Ultrashort Pulse Laser	81
3.	Generation of Induced Structures in Rare-Earth-Ions-Doped Glasses	86
3.1	Introduction	86
3.2	Room-Temperature Spectral Hole Burning of Sm-Doped Glass Fibers	87
3.3	X-ray-Induced Structure and Photostimulated Luminescence in Reduced Rare-Earth-Ion-Doped Glasses	90
3.3.1	Photostimulated Luminescence in Eu ²⁺ -Doped Fluoroaluminate Glasses	91
3.3.2	Photostimulated Luminescence in Ce ³⁺ -Doped Alkali Borate Glasses	95
3.4	Creation of Long-Lasting Phosphorescence in Rare-Earth- Ion-Doped Glasses	100
3.4.1	Long-Lasting Phosphorescence in Eu ²⁺ -Doped Glasses Induced by UV Light	101
3.5	Femtosecond-Laser-Induced, Three-Dimensional, Bright and Long-Lasting Phosphorescence Inside Calcium Aluminosili- cate Glasses Doped with Rare-Earth Ions	108
3.6	Valence-State Control of Rare-Earth Ions in Glasses by Using a Femtosecond Laser and Its Application to Ultrahigh-Density Optical Memories	113

3.6.1 Permanent Reduction of Eu^{3+} to Eu^{2+}
in a Fluorozirconate Glass Produced
by an Infrared Femtosecond Laser-Pulse 113

3.6.2 Permanent Photoreduction of Sm^{3+} to Sm^{2+}
in Sodium Aluminoborate Glass 117

Part 2. Analyses of Induced Structures in Glasses

4. Development of Analytical Methods for Induced Structures 125

4.1 Introduction 125

4.2 Direct Observation of Excited-State Absorption
Using Laser-Flash Pump-Probe Spectroscopy 125

4.3 Determination of Local Arrangement
by X-ray Absorbption Fine-Structure Analysis 131

4.4 The Study of Induced Structures
by Microscopic Raman Scattering 138

5. Computer Simulation of Induced Structures 144

5.1 Introduction 144

5.2 Simulation of Photoinduced Electronic Structures
in SiO_2 Glass Using Discrete Variational (DV)- $X\alpha$ 144

5.2.1 Making an Amorphous Structure 145

5.2.2 Molecular Orbital Calculation 146

5.2.3 Density of States and Partial Density of States 147

5.3 Design and Analysis of Photonic Crystals
Fabricated Using Glasses 150

Part 3. Functional Devices Using Active Glasses

6. Active Glasses for Functional Devices 157

6.1 Introduction 157

6.2 Micro-Sphere Lasers 157

6.3 Tm^{3+} -Doped Active Glasses
for UV and Blue Upconversion Lasers 164

6.4 Electroluminescence from Semiconductor-Microcrystal-Doped
Indium-Tin-Oxide Thin Films 172

6.5 Optical Poling of Dye-Doped Polymers
and its Application in Image Storage 180

6.5.1 Thermally-Assisted Optical Poling
of Thermally-Crosslinked Polymers 180

6.5.2 Optical Image Storage Based on All-Optical Poling
of Polymer Films 187

6.5.3	All-Optical Poling of Polymer Films Using a Femtosecond Laser	187
6.6	The Faraday Effect in Glasses to Obtain Magneto-Optical Switches	188
6.6.1	Wavelength Dispersions of the Faraday Effect in Chalcogenide Glasses	189
6.6.2	Influence of a Glass Matrix on the Faraday Effect in Eu^{2+} -Containing Glasses	193
6.7	Long-Period Optical Fiber Gratings Fabricated Using a Femtosecond Laser	200
7.	Ultrafast Optical Switches	208
7.1	Introduction	208
7.2	THz Optical Switching in Glasses Containing Bismuth Oxide	208
7.2.1	Preparation of Glasses	208
7.2.2	Optical Kerr Shutter Measurements	209
7.2.3	Optical Kerr Shutter Measurements Using 1.5-THz Pulse Trains as the Gate Beam	209
7.2.4	Properties of All-Optical Switches	210
7.3	Ultrafast Optical Kerr Shutters Using Metallic Nanoparticles Dispersed in Glasses	213
	References	219
	Index	231