

---

## Contents

<b>1</b>	<b>An Introduction to Chalcogenide Glasses</b>	1
1.1	Introduction	1
1.2	Structure of Chalcogenide Glasses	1
1.3	Electronic Properties of Chalcogenide Glasses	6
1.3.1	Electronic States in Chalcogenide Glasses	6
1.3.2	Measurements of the Absorption Coefficient and the Optical Gap	8
1.4	Chalcogenide Glasses for Near-Infrared Optics	10
1.5	Chalcogenide Glasses for Mid-IR and Far-IR Applications	12
1.6	Bulk Chalcogenide Glasses, Composition, and Optical Constants	14
1.7	Chalcogenide Thin Films and Comparison with the Bulk	17
1.8	Photoinduced Changes in Chalcogenide Glasses	21
1.8.1	Photoinduced Phenomena	21
1.8.2	Exposure Characteristics	23
1.8.3	Measurements of the Propagation Losses by a Prism Coupler	25
1.8.4	Measurements of Propagation Losses in Laser-Written Waveguides	26
1.9	Summary	27
<b>2</b>	<b>Basic Concepts of Nonlinear Optics</b>	29
2.1	Polarization	29
2.2	Wave Equation	30
2.2.1	Linear Optics	31
2.2.2	Nonlinear Optics	34
2.3	The Harmonic Oscillator Model in Linear Optics	37
2.4	The Anharmonic Oscillator Model in Nonlinear Optics	40
2.5	Properties of Anisotropic Media	42
2.6	Second-Harmonic Generation	43

2.7	Self-Phase Modulation and Soliton Generation	44
2.7.1	Optical Solitons	45
2.7.2	Mechanisms of Nonlinearity	47
2.7.3	Optical Phase Conjugation	48
2.7.4	Optical Bistability	50
2.7.5	Stimulated Raman Scattering	51
2.7.6	Third-Harmonic Generation	52
<b>3</b>	<b>Experimental Techniques to Measure Nonlinear Optical Constants</b>	<b>55</b>
3.1	Introduction	55
3.2	Degenerate Four-Wave Mixing	55
3.3	Nearly Degenerate Three-wave Mixing	59
3.4	Z-Scan	61
3.5	Third-Harmonic Generation	63
3.6	Optical Kerr Gate and Ellipse Rotation	64
3.6.1	Optical Kerr Gate	64
3.6.2	Ellipse Rotation	66
3.7	Self-Phase Modulation	67
3.8	Spectrally Resolved Two-Beam Coupling	69
3.9	Mach-Zehnder Interferometry	70
3.10	Summary	73
<b>4</b>	<b>Measurement of Nonlinear Optical Constants</b>	<b>75</b>
4.1	Measurements of Nonlinear Refractive Index $n_2$	75
4.2	Measurements of Nonlinear Absorption Coefficient $\beta$	91
4.3	Determination of Three Photon-Absorption and Multiphoton Absorption	94
4.4	Second-Harmonic Generation, Phase Conjugation, etc	95
4.5	Comparison of Chalcogenide Nonlinearities with Silica	102
<b>5</b>	<b>Optical Nonlinearities in Chalcogenide Fibres</b>	<b>107</b>
5.1	Fabrication of Chalcogenide Fibers and Their Linear Optical Properties	107
5.1.1	Fabrication of Fibers by Extrusion	108
5.1.2	Physical and Linear Optical Properties of Chalcogenide Fibers	109
5.2	Nonlinear Optical Properties of Fibers	111
5.2.1	Features of Chalcogenide Glass as a Nonlinear Material	111
5.2.2	Stimulated Light Scattering and Super-Continuum Generation	112
5.2.3	Second-Order Nonlinearity in Poled Glass	113

5.3	Pulse Propagation in Fibers .....	114
5.3.1	Propagation of Optical Fields .....	114
5.3.2	Nonlinear Pulse Propagation .....	116
5.3.3	Higher-Order Nonlinear Effects .....	120
5.4	Group-Velocity Dispersion Compensation by Fiber Gratings ..	121
5.5	Applications .....	122
<b>6</b>	<b>Optical Switching in Chalcogenide Glasses .....</b>	<b>129</b>
6.1	Criteria of Material Properties for All-optical Switching .....	129
6.2	Design Issues for All-Optical Switching .....	131
6.3	All-Optical Switching in Chalcogenide Glasses .....	131
6.3.1	All-Optical Switching using Chalcogenide Glass Fibers.....	131
6.3.2	All-Optical Switching in Thin Chalcogenide Films .....	137
6.4	All-Optical Switches, AND Gate, NOR Gate, etc. ....	145
6.4.1	Introduction .....	145
6.4.2	Nonlinear Interferometric Devices .....	147
6.4.3	Nonlinear Beam-Coupling Devices .....	147
6.4.4	Polarization Switching Devices .....	148
6.4.5	Soliton Switching Devices .....	148
6.5	Limitations of All-Optical Switches .....	149
6.6	Summary .....	149
<b>7</b>	<b>Issues and Future Directions .....</b>	<b>151</b>
7.1	Optical Limiting .....	151
7.2	Second-Harmonic Generation and Electro-Optic Effects .....	153
7.3	Fabrication of Rib and Ridge Waveguides and of Fiber Gratings .....	155
7.4	All-Optical Nonlinear Integrated Circuits .....	166
7.5	Inclusion of Metal Nanoparticles to Enhance Nonlinearity .....	168
7.6	Other Applications .....	169
7.7	Summary .....	175
	<b>References .....</b>	<b>177</b>
	<b>Index .....</b>	<b>195</b>

