## **Contents**

1.		C.S. Ts	sai (With 3 Figures)					. 1
	Ref	erence	s					. (
2.	By 6 2.1 2.2 2.3 2.4	G. Wad A Sin Histo Heuri Paran	ve Acousto-Optic Bragg Diffraction de (With 12 Figures) nple Experiment rical Perspective sistic Picture netric Excitation and Bragg Diffraction		· · ·			12 13 19 29
	2.5		antum-Mechanical Point-of-View Theory					
	2.7		mple Calculation					
	2.8		Reflection Case					
	2.9		ringent Bragg Diffraction					
	2.10	Acou	sto-Optic Materials					4:
			lusion					
	Ref	erence	s					5(
3.	Optical Waveguides - Theory and Technology By R.C. Alferness and P.K. Tien (With 22 Figures)							
	3.1		ground					
	3.2		Equations and Wave Vectors					
	3.3		Zigzag-Wave Model					
	3.4		Potential-Well Model					
	3.5		Equations of a Slab Waveguide					
	3.6		Equations of a Channel Waveguide					
	3.7		tive-Index Method					
	3.8		sed Waveguides and the WKB Method					
	3.9		guide Materials					
			Glass					
			Semiconductor					
			Channel Waveguides					
		3.9.5	Ridge and Metal-Clad Channel Waveguides					
			Coupling to a Dielectric Waveguide					
			The Prism					
			Fiber-Waveguide Coupling					86
	Ref	erence	s					89



VII

4.	EX	citatio	on of Surface-Acoustic Waves by Use of Interdigital			
	Electrode Transducers					
	$\mathbf{B}\mathbf{y}$	y T.M. Reeder (With 12 Figures)				
	4.1	Func	damentals of Transducer Operation	92		
		4.1.1	Equivalent Circuit Model	92		
		4.1.2	Transducer Admittance and Conversion Efficiency	. 97		
		4.1.3	An Important Example	. 99		
	4.2	Desig	gn of Transducer and Coupling Networks	. ,,		
		for E	Broad-Band Operations	102		
		4.2.1	The Transducer-Circuit Sub-System	102		
		4.2.2	Broad-Band Acoustic Design	102		
		4.2.3	Broad-Band Electric Circuit Design	107		
		4.2.4	Parasitic and Second-Order Effects	111		
	4.3	Sumr	mary	111		
	Ref	erence	28	113		
			~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~ ~	114		
5.	Wic	lebano	d Acousto-Optic Bragg Diffraction in LiNbO3			
	Wa	veguio	de and Applications			
	By	C.S. T	sai (With 54 Figures)	117		
	5.1	Guid	ed-Wave Acousto-Optic Bragg Interactions in Planar	11/		
		Wave	guides	117		
		5.1.1	Basic Planar Acousto-Optic Bragg Interaction	11/		
			Configuration and Mechanisms	117		
		5.1.2	Coupled-Mode Analysis on Acousto-Optic Bragg	11/		
			Diffraction from a Single-Surface Acoustic Wave	121		
		5.1.3	Diffraction Efficiency and Frequency Response	121		
		5.1.4	Three Potential Acousto-Optic Substrate Materials	123		
			a) LiNbO <sub>3</sub> Substrate	127		
			b) GaAs Substrate	132		
			c) SiO <sub>2</sub> , As <sub>2</sub> S <sub>3</sub> or SiO <sub>2</sub> -Si Substrates	132		
	5.2	Kev	Performance Parameters of Basic Planar Acousto-Optic	133		
		Bragg	Modulators and Deflectors	125		
		5.2.1	Bandwidth	135		
		5.2.2	Time-Bandwidth Product	135		
		5.2.3	Acoustic and RF Drive Powers	136 137		
		5.2.4	Nonlinearity and Dynamic Range			
	5.3	Guide	ed-Wave Acousto-Optic Bragg Diffraction from Multiple	139		
		Surfa	ce Acoustic Waves	141		
		5.3.1	Acousto-Optic Bragg Diffraction from Two Tilted SAWs	141		
		5.3.2	Acousto-Optic Bragg Diffraction from N-SAWs			
		5.3.3	Two Specific Wide-Band Configurations	145		
		0.0.0	a) Tilted-SAWs Configuration	147		
			b) Phased-SAWs Configuration	147		
	5.4	Realis	zation of Wide-Band Planar Acousto-Optic Bragg	148		
•	· · ¬	Modu				
		5.4.1	Principle and Design Procedure	149		
		J.7.1	of Wide-Band Device Configurations			
			or wide band bevice Comigurations	101		

		a) Isotropic Diffraction with Multiple Tilted	
		Transducers of Staggered Center Frequency	151
		b) Isotropic Diffraction with Phased-Array	13.
		Transducers	154
		c) Isotropic Diffraction with Multiple Tilted	1 )-
		Phased-Array Transducers	155
		d) Isotropic Diffraction with a Single Tilted-Finger, Chi	133
		Transducer or on Array of Such Transducers	irp
		Transducer or an Array of Such Transducers	156
		e) Optimized Anisotropic Diffraction with Multiple	
		Transducers of Staggered Center Frequency	
	5.4.3	or a Parallel-Finger Chirp Transducer	157
	5.4.2		
		Device Performance	159
		a) Isotropic Device with Multiple Tilted Transducers of	
		Staggered Center Frequency	160
		b) Isotropic Device with Multiple, Tilted Transducers	
		of Improved Geometry	164
		c) Isotropic Device with Phased-Array Transducers	165
		d) Isotropic Device with a Tilted-Finger,	
		Chirp Transducer	167
		e) Optimized Anisotropic Device with a Single	
		Transducer of Large Aperture	169
	5.4.3	Relative Merits of Single Transducer Versus Multiple	
		Transducers	171
	5.5 Appl	lications in Optical Communications, Signal Processing, and	d T
	Com	puting	 172
	5.5.1	Optical Communications	172
		a) Digital Deflection and Switching	173
		b) Analog Deflection and Switching	174
		c) Electronically Tunable Optical Wavelength Filtering	178
		d) Wide-Band Optical Frequency Shifting	178
	5.5.2	Optical Signal Processing	178
	0.5.2	a) Spectral Anlysis of Very Wide-Band RF Signals	180
		b) Convolution of Wide-Band RF Signals	
		c) Compression of RF Chirp Pulse	183
		d) Correlation of Wide Bond DE Single	185
	552	d) Correlation of Wide-Band RF Signals	187
	5.5.5	Optical Computing	190
	Defense	mary	191
	Reference	es	192
c	C:4-4 S	Vanna Alaanska Oak'a Taka a' ' G O Mil' Mil	
Э.		Wave Acousto-Optic Interaction in a ZnO Thin Film	
		piezoelectric Substrate	
	By N. Mil.	koshiba (With 26 Figures)	205
	o.i Fabri	ication of ZnO Thin Film	205
	6.1.1	DC Sputtering	205
	6.1.2	RF Sputtering	207
	6.1.3	Chemical Vapor Deposition	208
	6.1.4	Some Other Methods	209

		6.1.5	Progress in ZnO Technology	210
	6.2	The 2	ZnO Thin-Film Waveguide	210
		6.2.1	Fused Quartz Substrate	210
		6.2.2	Sapphire Substrate	211
		6.2.3	Si Substrate	213
	6.3	Excit	ation of SAW by ZnO Thin Films	213
	6.4	Photo	pelastic Effect in ZnO	216
	6.5	Acou	sto-Optic Interaction in ZnO Thin Film	220
		6.5.1	Diffraction Efficiency	220
		6.5.2	Bragg Condition	227
		6.5.3	Mode Conversion; $TE \stackrel{\leftarrow}{\rightarrow} TM$ , $TM_i \stackrel{\leftarrow}{\rightarrow} TM_i \dots \dots$	228
	6.6	Comb	oined Structure of ZnO and Other Thin Films	231
	Ref	erence	s	231
7	Sna	0 t = 11 m	Apolysis with Interest 4 Out a	
٠.	By i	MCI	Analysis with Integrated Optics Hamilton and A.E. Spezio (With 18 Figures)	235
	7.1	A cou	sto-Optic Spectrum Analysis	235
	, . <b>.</b>	7.1.1		233
			Dynamic Range	239
	7.2	The I	ntegrated Optical Spectrum Analyzer	240
		7.2.1	IOSA Features	240
		7.2.2	Size Constraints	241
		7.2.3		242
			Materials	245
	7.3	Comr	ponents	246
		7.3.1	Laser and Laser/Waveguide Coupling	246
			a) Semiconductor Diode Laser Characteristics	246
			b) Butt-Coupling	248
		7.3.2	Waveguides	249
			a) Silicon	249
			b) Lithium Niobate	249
		7.3.3	Waveguide Lenses	250
			a) Generalized Waveguide Luneburg Lens	252
			b) Diffraction Lenses	253
			c) Geodesic Lenses	253
		7.3.4	Wideband Waveguide Bragg Cells	256
			a) Frequency Dependence of the Diffraction Efficiency	256
			b) Wideband Transducer Configurations	257
			c) SAW Attenuation	258
		7.3.5	Detection and Signal Processing	259
			a) Detector Array Architecture	259
			b) Post-Detection Processing	260
			c) Detector Sensitivity	260
			d) Dynamic Range	261
			e) Speed	262
			f) Photodetector Pitch	263
	7 4	IOC 4	g) Photodetector Coupling	263
	1.4	IOSA	Demonstrations	264

	7.5		265
			266
			267
			268
			269
	Ref	erences	269
8.		grated Acousto-Optic Device Modules and Applications	
		` ' '	273
	8.1	RF Spectrum Analyzer Modules in Nonpiezoelectric Substrates	273
	8.2	Acousto-Optic Time-Integrating Correlator Module Using	
	0.2		276
	8.3	Crossed-Channel Waveguide Acousto-Optic Modulator/	_,,
	0.5		278
	8.4	Channel-Planar Composite Waveguide Acousto-Optic Bragg	
	0.7		279
	8.5	Multichannel RF Correlator Modules Using Acousto-Optic	
	0.5		286
	8.6		289
	8.7	GaAs Acousto-Optic Bragg Cell and RF Spectrum	20)
	0.7		291
		8.7.1 Geometry, Design and Fabrication	2)1
			292
			293
			297
			298
	8.8	Spherical Waveguide Acousto-Optic Bragg Modulator/	
	0.0		300
		8.8.1 Optical Guiding and Propagation in a Spherical	200
		Waveguide and Acousto-Optic Interaction	
		·	300
			302
		8.8.3 Applications to Communications and RF Signal	J <b>U</b> 2
			303
		8.8.4 Spherical Waveguide Acousto-Optic Frequency	505
			304
			308
	8.9		308
			309
			,
Su	bjec	t Index	317