CONTENTS

PREFACE		Xi		
CUMULATIVE LISTING OF VOLUMES IN SERIES				
CHAPTER 1	INTRODUCTION			
	1.1 Piezoelectricity and the Genesis of Acoustic Wave Devices	2		
	1.2 The Advent of Chemical Sensor Technology	6		
	1.3 Acoustic Wave Devices and Chemical Sensor Technology	9		
	1.4 Brief Overview of the Text	12		
	References	13		
CHAPTER 2	ACOUSTIC WAVES IN SOLIDS AND DEVICE STRUCTURE	17		
	2.1 Elasticity of Solids	17		
	2.2 Piezoelectricity	20		
	2.2.1 Piezoelectric Materials	20		
	2.2.2 Coupling of Electromagnetism to Solid Elasticity	24		
	2.2.3 Piezoelectric Wave Equations	28		
	2.2.4 Resonance	31		
	2.3 Particle Displacement and Acoustic Waves	31		
	2.4 Acoustic-Wave Devices Employed to Study Interfacial Chemistry	34		
	2.4.1 The Thickness-Shear Mode Sensor	35		
	2.4.2 Surface-Launched Acoustic Wave Devices	37		
	2.4.3 Nonpiezoelectric Acoustic Wave	57		
	Devices	46		

CONTENTS

2.4.4 Brief Comparison of Devices References

THEORY OF ACOUSTIC WAVE SENSOR **CHAPTER 3** RESPONSE

- 3.1 Basic Theory of Operation
- 3.2 Physical Parameters Affecting SAW Sensor Response
 - 3.2.1 Effect of Operating Temperature
 - 3.2.2 Effect of Applied Pressure
 - 3.2.3 Effect of Applied Electric Potential
- 3.3 Influence of Surface Morphology
- 3.4 Effect of an Electrically- Insulating Surface Film
- 3.5 Influence of a Conducting Surface Film
- 3.6 Operation in Liquid Environments
 - 3.6.1 Thin Liquid Overlayer
 - 3.6.2 Thick Liquid Overlayer
- 3.7 Vapor Sorption and Temperature Effects with **Polymeric Films**
 - 3.7.1 Vapor Sorption into a Polymeric Film
 - 3.7.2 Temperature Effects on Polymeric Films
 - 3.7.3 Combined Temperature and Vapor Sorption
 - 3.7.4 Summary
- 3.8 Dielectric and Solution Conductivity Effects
 - 3.8.1 Dielectric Loss Effects
 - 3.8.2 Solution Conductivity Effects References

CHAPTER 4 SAW DEVICE OPERATION AND MEASUREMENT

- 4.1 Interdigital Transducer Capacitance
- 4.2 IDT Function on Piezoelectric Substrates
- 4.3 Equivalent Circuit of an IDT
- 4.4 Device Design and Fabrication
- 4.5 SAW Sensor Operation

	CONTENTS			
	4.5.1 Oscillator-Based Measurements	106		
	4.5.2 Phase/Amplitude-Based Measurements	110		
4.6 Signal Referencing				
	References	114		
CHAPTER 5	SENSOR COATINGS AND SAMPLE GENERATION			
	5.1 Response of SAW Chemical Sensors			
	5.1.1 Static Measurements	119		
	5.1.2 Dynamic Measurements	119		
	5.1.3 Sensor Response Theory	120		
	5.1.4 Implications of Sensor Response Theory	123		
	5.2 Response Normalization and Interaction	125		
	Mechanisms	126		
	5.2.1 Sensor Partition Coefficients	127		
	5.2.2 Linear Solvation Energy Relationships	129		
	5.3 Coating Materials and Methods	130		
	5.3.1 Solvent Evaporation	132		
	5.3.2 Langmuir-Blodgett Films	132		
	5.3.3 Self-Assembled Monolayers	138		
	5.3.4 Covalent Attachment	143		
	5.3.5 Inorganic Coatings	143		
	5.3.6 Physical Entrapment	144		
	5.4 Sample Generation and Handling	145		
	5.4.1 Carrier Streams and Flow Control	147		
	5.4.2 Gas and Vapor Samples	147		
	5.4.3 SAW Detector Housings	151		
	5.4.4 Gas-Chromatographic Systems	151		
	5.4.5 Liquid-Phase Measurements	153		
	References	153		
CHAPTER 6	APPLICATIONS OF ACOUSTIC WAVE SENSORS IN ANALYTICAL CHEMISTRY	157		
	6.1 Gas-Phase Chemical Sensor Technology	158		
	6.1.1 Detection of Inorganic Gases	158		
	6.1.2 Selective Detection of Organic Vapors	161		

CONTENTS

	6.2	Study	of Thin-Film Properties	165
		6.2.1	Polymer Thermomechanical Properties	165
		6.2.2	Diffusion in Gels	165
		6.2.3	Film Process Monitoring	167
		6.2.4	Static and Dynamic Glass Transitions of Polymers	168
		6.2.5	Sorption Studies with Structured Films	169
	6.3		stic Wave Devices in the Biosensor	
		Form	at	170
	6.4	Senso	or Arrays and Pattern Recognition	174
		6.4.1	Chemistry and Physics of Analytical Selectivity, Specificity, and Sensitivity	175
		6.4.2	Pattern Recognition	176
			Arrays of Acoustic Wave Sensors	178
			Sensor Arrays as a Metaphor for the Human Olfactory System—the	
			"Electronic Nose"	181
	6.5	Futur	e Perspectives	182
		Refer	ences	185
APPENDIX A	GLOSSARY OF SYMBOLS			189
INDEX				191