

Contents

Foreword — V

Preface — VII

Glossary of symbols and scientific notations — XV

Introduction — 1

Part 1: Photodetector structures

Chapter 1

Photodiode structures with a high-resistance layer — 7

- 1.1 Introduction: injection amplification of photocurrent in CdTe-based diode structures — **7**
- 1.1.1 Principle of photocurrent amplification — **7**
- 1.1.2 Current-voltage characteristics of diodes — **8**
- 1.1.3 Spectral characteristics of diodes — **9**
- 1.1.4 Evaluation of photosensitivity and noise of diode structures — **10**
- 1.1.5 Speed of diodes — **12**
- 1.1.6 Mechanism of photosensitivity of diode structures by energy diagrams — **13**
- 1.1.7 Mechanism of photosensitivity of diodes at forward bias — **15**
- 1.2 Summary — **17**

Chapter 2

Cadmium telluride-based highly sensitive photosensors — 18

- 2.1 Introduction — **18**
- 2.2 Cadmium telluride-based injection detectors for ionizing radiation — **18**
- 2.3 Mechanism of free carrier generation upon irradiation by high energy photons — **19**
- 2.4 Diode characteristics and parameters under X-ray irradiation — **20**
- 2.5 Dose sensitivity of diodes exposed to X-radiation — **23**
- 2.6 Thresholds and detection ability of diodes under X-radiation — **24**
- 2.7 Interconnection of sensitivity in the intrinsic and X-ray regions of the spectrum — **25**
- 2.8 Summary — **26**

Chapter 3

Cadmium telluride and silicon-based photodiodes — 28

- 3.1 Introduction — **28**
- 3.2 Cadmium telluride-based diodes — **28**
- 3.3 Silicon-based diodes — **29**
- 3.4 Mechanism of spectral photocurrent sign change in diode structures — **32**
- 3.5 Dependence of the thickness of the energy barriers on the external voltage in structures with a high-resistance layer between Schottky barriers — **35**
- 3.6 Dark current-voltage characteristics of a structure with a high-resistance thin layer between oppositely directed Schottky barriers — **39**
- 3.7 Light current-voltage characteristics of two-barrier diode structures with a high-resistance thin layer between oppositely directed Schottky barriers — **41**
- 3.8 Summary — **44**

Part 2: Methods of spectral-selective sensitivity of optical radiation

Chapter 4

Spectral-selective sensitivity of optical radiation — 47

- 4.1 Introduction — **47**
- 4.2 Detectors with selective spectral sensitivity — **47**
- 4.3 Spectrophotometric properties of photodetectors with two-barrier structures: advantages and disadvantages — **52**
- 4.4 State-of-the-art capabilities of the optical spectral analysis — **54**
 - 4.4.1 Light sources — **58**
 - 4.4.2 Detectors — **60**
- 4.5 Summary — **64**

Part 3: Structural and technological aspects

Chapter 5

Structural and technological aspects of photodetectors — 69

- 5.1 Introduction — **69**
- 5.2 Structural features of the photodetectors derived for photospectrometry — **69**
- 5.3 Relating structural, energy, and technological parameters of photodetectors — **73**

- 5.4 Structural layers of the spectrometric photodetector — **80**
- 5.4.1 Forming p^+ and n layers — **80**
- 5.5 Ohmic contacts and the technological parameters of the structure — **81**
- 5.6 Choice of the silicide barrier — **83**
- 5.7 Summary — **85**

Part 4: Measurement methods and photoelectronic characteristics

Chapter 6

Photoelectronic characteristics and measurement methods — 89

- 6.1 Introduction — **89**
- 6.2 Current-voltage characteristics — **89**
- 6.3 Volt-farad characteristic — **95**
- 6.4 $p^+(PtSi)-n(Si)-p^+(Si)$ structure and parametric dependence of absorbed radiation — **98**
- 6.5 Summary — **103**

Part 5: Research results

Chapter 7

Performance assessment of photodetectors — 107

- 7.1 Introduction — **107**
- 7.2 Performance capabilities of the spectral-selective sensitivity of the photodetectors — **107**
- 7.3 Noises in the $p^+(PtSi)-n(Si)-p^+(Si)$ structure: performance and threshold photosensitivity — **112**
- 7.4 Speed assessment — **114**
- 7.5 The efficiency assessment of the work in terms of the current demands — **114**
- 7.6 Summary: a demand analysis of the proposed photodetectors — **117**

Part 6: On the semiconductor spectroscopy

Chapter 8

Identification of emergent contaminants in transparent media — 121

- 8.1 Introduction — **121**
- 8.2 State-of-the-art semiconductor spectroscopy — **121**
- 8.2.1 Innovative method of spectroscopy — **122**

8.3	Photoelectronic processes: selective spectral sensitivity —	123
8.3.1	Tunneling issues —	124
8.4	Interrelation of structural parameters —	125
8.4.1	Optimal design of photodetectors —	126
8.5	Deriving the photocurrent expression for selected structures —	127
8.6	Case studies of three typical samples —	130
8.6.1	Silicide-n-p —	130
8.6.2	Silicon-n-p-n —	131
8.6.3	Silicon1-n-p-n —	132
8.6.4	Mechanism of the selective spectral sensitivity —	136
8.6.5	Injection amplification of the photocurrent —	139
8.7	Summary —	141

Chapter 9

Spectral sensitivity — 142

9.1	Introduction —	142
9.2	Selective spectral sensitivity of oppositely placed double-barrier structures —	142
9.3	Experimental device structure —	143
9.4	Results from experimental structure —	145
9.5	Summary —	151

Chapter 10

High photosensitivity in two-barrier photodetectors — 152

10.1	Introduction —	152
10.2	High photosensitivity in two-barrier structures —	152
10.3	Research directions —	153
10.4	Results of two-barrier structures —	154
10.5	Mechanism of high photosensitivity —	156
10.6	Summary —	160

References — 163

About the authors — 171

Index — 173