

1. Record Nr.	UNINA9910826172603321
Titolo	Semiconductor terahertz technology : devices and systems at room temperature operation // editors, Guillermo Carpintero, Luis Enrique Garcaia-Muanoz, Hans H. Hartnagel, Sascha Preu
Pubbl/distr/stampa	Hoboken [New Jersey] : , : John Wiley & Sons, Inc., , 2015 [Piscataqay, New Jersey] : , : IEEE Xplore, , [2015]
ISBN	1-118-92039-2 1-118-92041-4 1-118-92040-6
Descrizione fisica	1 online resource (427 p.)
Collana	Wiley - IEEE
Disciplina	621.381/33
Soggetti	Terahertz technology Semiconductors Submillimeter waves Very high speed integrated circuits
Lingua di pubblicazione	Inglese
Formato	Materiale a stampa
Livello bibliografico	Monografia
Note generali	Description based upon print version of record.
Nota di bibliografia	Includes bibliographical references at the end of each chapters and index.
Nota di contenuto	Acknowledgments xi -- Preface xiii -- Foreword xvii -- List of Contributors xix -- 1 General Introduction 1 /Hans Hartnagel, Antti V. Raisanen, and Magdalena Salazar-Palma -- 2 Principles of THz Generation 3 /Sascha Preu, Gottfried H. DŠohler, Stefan Malzer, Andreas StŠohr, Vitaly Rymanov, Thorsten GŠobel, Elliott R. Brown, Michael Feiginov, Ramon Gonzalo, Miguel Beruete, and Miguel Navarro-Cya -- 2.1 Overview 3 -- 2.2 THz Generation by Photomixers and Photoconductors 5 -- 2.2.1 Principle of Operation 5 -- 2.2.2 Basic Concepts and Design Rules 7 -- 2.2.3 Thermal Constraints 21 -- 2.2.4 Electrical Constraints 23 -- 2.2.5 Device Layouts of Photoconductive Devices 35 -- 2.2.6 Device Layouts of p-i-n Diode-Based Emitters 47 -- 2.3 Principles of Electronic THz Generation 53 -- 2.3.1 Oscillators with Negative Differential Conductance 54 -- 2.3.2 Multipliers (Schottky Diodes, Hetero-Barrier Varactors) 56 -- 2.3.3 Plasmonic Sources 58 -- References 61 -- 3 Principles of Emission of THzWaves

69 /Luis Enrique Garcya Munoz, Sascha Preu, Stefan Malzer, Gottfried H. D
ohler, Javier Montero-de-Paz, Ramon Gonzalo, David Gonzalez-Ovejero, Daniel Segovia-Vargas, Dmitri Lioubtchenko, and Antti V. Raisanen -- 3.1 Fundamental Parameters of Antennas 69 -- 3.1.1 Radiation Pattern 69 -- 3.1.2 Directivity 71 -- 3.1.3 Gain and Radiation Efficiency 71 -- 3.1.4 Effective Aperture Area and Aperture Efficiency 72 -- 3.1.5 Phase Pattern and Phase Center 72 -- 3.1.6 Polarization 72 -- 3.1.7 Input Impedance and Radiation Resistance 72 -- 3.1.8 Bandwidth 73 -- 3.2 Outcoupling Issues of THz Waves 73 -- 3.2.1 Radiation Pattern of a Dipole over a Semi-Infinite Substrate 75 -- 3.2.2 Radiation Pattern of a Dipole in a Multilayered Medium 79 -- 3.2.3 Anomalies in the Radiation Pattern 82 -- 3.3 THz Antenna Topologies 84 -- 3.3.1 Resonant Antennas 85 -- 3.3.2 Self-Complementary Antennas 87 -- 3.4 Lenses 90 -- 3.4.1 Lens Design 90 -- 3.5 Techniques for Improving the Performance of THz Antennas 93 -- 3.5.1 Conjugate Matching Technique 93. 3.5.2 Tapered Slot Antenna on Electromagnetic Band Gap Structures 99 -- 3.6 Arrays 107 -- 3.6.1 General Overview and Spectral Features of Arrays 107 -- 3.6.2 Large Area Emitters 113 -- References 157 -- 4 Propagation at THz Frequencies 160 /Antti V. Raisanen, Dmitri Lioubtchenko, Andrey Generalov, J. Anthony Murphy, Creidhe O'Sullivan, Marcin L. Gradziel, Neil Trappe, Luis Enrique Garcia Munoz, Alejandro Garcia-Lamperez, and Javier Montero-de-Paz -- 4.1 Helmholtz Equation and Electromagnetic Modes of Propagation 160 -- 4.2 THz Waveguides 167 -- 4.2.1 Waveguides with a Single Conductor: TE and TM Modes 168 -- 4.2.2 Waveguides with Two or More Conductors: TEM and Quasi-TEM Modes 173 -- 4.2.3 Waveguides with No Conductor: Hybrid Modes 177 -- 4.3 Beam Waveguides 183 -- 4.3.1 Gaussian Beam 183 -- 4.3.2 Launching and Focusing Components: Horns, Lenses, and Mirrors 187 -- 4.3.3 Other Components Needed in Beam Waveguides 193 -- 4.3.4 Absorbers 195 -- 4.3.5 Modeling Horns Using Mode Matching 195 -- 4.3.6 Multimode Systems and Partially Coherent Propagation 199 -- 4.3.7 Modeling Techniques for THz Propagation in THz Systems 201 -- 4.4 High Frequency Electric Characterization of Materials 202 -- 4.4.1 Drude Model 203 -- 4.4.2 Lorentz-Drude Model 204 -- 4.4.3 Brendel-Bormann Model 205 -- 4.5 Propagation in Free Space 205 -- 4.5.1 Link Budget 205 -- 4.5.2 Atmospheric Attenuation 206 -- References 207 -- 5 Principles of THz Direct Detection 212 /Elliott R. Brown, and Daniel Segovia-Vargas -- 5.1 Detection Mechanisms 212 -- 5.1.1 E-Field Rectification 213 -- 5.1.2 Thermal Detection 215 -- 5.1.3 Plasma-Wave, HEMT, and MOS-Based Detection 220 -- 5.2 Noise Mechanisms 223 -- 5.2.1 Noise from Electronic Devices 223 -- 5.2.2 Phonon Noise 225 -- 5.2.3 Photon Noise with Direct Detection 227 -- 5.3 THz Coupling 230 -- 5.3.1 THz Impedance Matching 230 -- 5.3.2 Planar-Antenna Coupling 231 -- 5.3.3 Exemplary THz Coupling Structures 232 -- 5.3.4 Output-Circuit Coupling 235 -- 5.4 External Responsivity Examples 235. 5.4.1 Rectifiers 235 -- 5.4.2 Micro-Bolometers 236 -- 5.5 System Metrics 239 -- 5.5.1 Signal-to-Noise Ratio 239 -- 5.5.2 Sensitivity Metrics 240 -- 5.6 Effect of Amplifier Noise 243 -- 5.7 A Survey of Experimental THz Detector Performance 244 -- 5.7.1 Rectifiers 246 -- 5.7.2 Thermal Detectors 247 -- 5.7.3 CMOS-Based and Plasma-Wave Detectors 249 -- References 250 -- 6 THz Electronics 254 /Michael Feiginov, Ramƒon Gonzalo, Itziar Maestrojuan, Oleg Cojocari, Matthias Hoefle, and Ernesto Limiti -- 6.1 Resonant-Tunneling Diodes 254 -- 6.1.1 Historic Introduction 254 -- 6.1.2 Operating Principles of RTDs 255 -- 6.1.3 Charge-Relaxation Processes in RTDs 256 -- 6.1.4

High-Frequency RTD Conductance 259 -- 6.1.5 Operating Principles of RTD Oscillators 260 -- 6.1.6 Limitations of RTD Oscillators 261 -- 6.1.7 Overview of the State of the Art Results 264 -- 6.1.8 RTD Oscillators versus Other Types of THz Sources 265 -- 6.1.9 Future Perspectives 265 -- 6.2 Schottky Diode Mixers: Fundamental and Harmonic Approaches 265 -- 6.2.1 Sub-Harmonic Mixers 267 -- 6.2.2 Circuit Fabrication Technologies 270 -- 6.2.3 Characterization Technologies 272 -- 6.2.4 Advanced Configuration Approach 276 -- 6.2.5 Imaging Applications of Schottky Mixers 277 -- 6.3 Solid-State THz Low Noise Amplifiers 278 -- 6.3.1 Solid-State Active Devices and Technologies for Low Noise Amplification 280 -- 6.3.2 Circuit and Propagation Issues for TMIC 282 -- 6.3.3 Low Noise Amplifier Design and Realizations 284 -- 6.3.4 Perspectives 287 -- 6.4 Square-Law Detectors 288 -- 6.4.1 Characterization and Modeling of Low-Barrier Schottky Diodes 289 -- 6.4.2 Design of Millimeter-Wave Square-Law Detectors 291 -- 6.5 Fabrication Technologies 292 -- 6.5.1 Overview of Fabrication Approaches of Schottky Structures for Millimeter-Wave Applications 293 -- 6.5.2 Film-Diode Process 296 -- References 299 -- 7 Selected Photonic THz Technologies 304 /Cyril C. Renaud, Andreas Stöhr, Thorsten Goebel, Frederic Van Dijk, and Guillermo Carpintero.

7.1 Photonic Techniques for THz Emission and Detection 304 -- 7.1.1 Overall Photonic System 304 -- 7.1.2 Basic Components Description 306 -- 7.1.3 Systems Parameters, Pulsed versus CW 307 -- 7.2 Laser Sources for THz Generation 309 -- 7.2.1 Pulsed Laser Sources 309 -- 7.2.2 Continuous Wave (CW) Sources 312 -- 7.2.3 Noise Reduction Techniques 314 -- 7.2.4 Photonic Integrated Laser Sources 315 -- 7.3 Photodiode for THz Emission 320 -- 7.3.1 PD Limitations and Key Parameters 320 -- 7.3.2 Traveling Wave UTC-PD Solution 322 -- 7.4 Photonically Enabled THz Detection 324 -- 7.4.1 Pulsed Terahertz Systems 325 -- 7.4.2 Optically Pumped Mixers 328 -- 7.5 Photonic Integration for THz Systems 331 -- 7.5.1 Hybrid or Monolithic Integrations 332 -- 7.5.2 Monolithic Integration of Subsystems 333 -- 7.5.3 Foundry Model for Integrated Systems 334 -- References 335 -- 8 Selected Emerging THz Technologies 340 /Christian Damm, Harald G. L. Schwefel, Florian Sedlmeir, Hans Hartnagel, Sascha Preu, and Christian Weickhmann -- 8.1 THz Resonators 340 -- 8.1.1 Principles of Resonators 341 -- 8.1.2 Introduction to WGM Resonators 343 -- 8.1.3 Evanescent Waveguide Coupling to WGMs 345 -- 8.1.4 Resonant Scattering in WGM Resonators 346 -- 8.1.5 Nonlinear Interactions in WGM 349 -- 8.2 Liquid Crystals 350 -- 8.2.1 Introduction 350 -- 8.2.2 Characterization 357 -- 8.2.3 Applications 365 -- 8.3 Graphene for THz Frequencies 367 -- 8.3.1 Theory and Material Properties 367 -- 8.3.2 Applications 373 -- References 377 -- Index 383.

Sommario/riassunto

Key advances in Semiconductor Terahertz (THz) Technology now promise important new applications enabling scientists and engineers to overcome the challenges of accessing the so-called “terahertz gap”. This pioneering reference explains the fundamental methods and surveys innovative techniques in the generation, detection, and processing of THz waves with solid-state devices, as well as illustrating their potential applications in security and telecommunications, among other fields. With contributions from leading experts, Semiconductor Terahertz Technology: Devices and Systems at Room Temperature Operation comprehensively and systematically covers semiconductor-based room-temperature operating sources such as photomixers, THz antennas, radiation concepts, and THz propagation, as well as room-temperature operating THz detectors. The second part of the book focuses on applications such as the latest photonic and electronic THz

systems, as well as emerging THz technologies including: whispering gallery resonators, liquid crystals, metamaterials, and graphene-based devices. This book will provide support for practicing researchers and professionals and will be an indispensable reference for graduate students in the field of THz technology. KEY FEATURES: * Includes crucial theoretical background sections to photomixers, photoconductive switches, and electronic THz generation and detection. * Provides an extensive overview of semiconductor-based THz sources and applications. * Discusses vital technologies for affordable THz applications. * Supports teaching and studying increasingly popular courses on semiconductor THz technology.
