

Contents

1 Introduction	1
1.1 Brief Introduction to Terahertz Electromagnetic Wave	1
1.2 Terahertz Sources	4
1.3 Terahertz Detectors	8
1.4 Outline of This Thesis	14
References	15
2 Field-Effect Self-Mixing Mechanism and Detector Model	19
2.1 The Physics of Terahertz Plasmon Detection	19
2.2 Quasi-Static Self-Mixing Detector Model	25
2.3 Simulation of Terahertz Antenna by Using FDTD Method	30
2.3.1 Principle of FDTD and the Algorithm	30
2.3.2 Antenna Simulation by FDTD	33
2.3.3 Terahertz Filter	36
2.4 Summary	38
References	38
3 Realization of Terahertz Self-Mixing Detectors	
Based on AlGaIn/GaN HEMT	41
3.1 Introduction	41
3.1.1 Gallium Nitride and High-Electron-Mobility Transistors	41
3.2 Detector Fabrication	50
3.3 Detector Characterization	55
3.3.1 Terahertz Response at Zero Source–Drain Bias	55
3.3.2 Terahertz Response Under a Finite Source–Drain Bias	63
3.3.3 Responsivity and Noise-Equivalent Power	70
3.3.4 Response Speed	74
3.3.5 Spectral Response	78
3.3.6 Polarization-Dependent Response	78

- 3.4 Detector Optimization 80
- 3.5 Summary 83
- References 84
- 4 Realization of Resonant Plasmon Excitation and Detection 87**
 - 4.1 Introduction 87
 - 4.2 Detector with a Symmetric Antenna 89
 - 4.3 Antenna Simulation 90
 - 4.4 Resonant Plasmon Detection 91
 - 4.5 The Effect of Symmetry 93
 - 4.6 Summary 94
 - References 95
- 5 Scanning Near-Field Probe for Antenna Characterization 97**
 - 5.1 Introduction 97
 - 5.2 Scanning Probe Setup 98
 - 5.3 Scanning Near-Field Photocurrent 100
 - 5.4 Summary 104
 - References 104
- 6 Applications 107**
 - 6.1 Single-Pixel Terahertz Imaging 107
 - 6.1.1 Terahertz Transmission Imaging 108
 - 6.1.2 Terahertz Reflection Imaging 110
 - 6.2 Linear Detector Array 112
 - 6.3 Detectors for Fourier Transform Spectroscopy 113
 - 6.4 Summary 114
 - References 115
- 7 Conclusions and Outlook 119**
 - References 121
- Appendix A: Symbols 123**
- Appendix B: Experiment Setup 125**