

Contents

Publications.....	III
Kurzfassung.....	IV
Abstract.....	V
Contents.....	VII
1 Introduction.....	1
2 Terahertz Thin-Film Sensing.....	5
2.1 THz-TDS and Improvements.....	6
2.2 Resonators in Parallel-Plate Waveguides.....	7
2.3 Metal Hole Arrays.....	9
2.4 Metasurfaces.....	10
2.5 "Sensitivity".....	11
3 Split-Ring Resonator Arrays.....	13
3.1 Frequency Selective Surfaces.....	13
3.2 Split-Ring Resonators.....	15
3.3 Conductivity (Gold at 1 THz).....	19
3.4 Substrate Influence.....	20
3.5 E-field Concentration.....	21
3.6 Babinet Principle.....	22
3.7 SRRs for Metamaterials.....	23
4 Biochip Design.....	25
4.1 Simulations with HFSS.....	25
4.2 Simulation Parameters for DNA.....	27
4.3 The Asymmetric Double-Split Ring Resonator (aDSR).....	30
4.4 Substrates.....	32
4.5 Sample Position and Complementary FSS.....	34
4.6 FSS / Array Design.....	37
4.6.1 Polarization.....	39
4.6.2 Finite Array.....	40
4.7 280 GHz Biochip Technology.....	42
4.8 Biochip Production Process.....	43
4.9 Linear Scalability.....	46
4.10 Adapted Version for 560 GHz.....	47

5	Biochip Reader.....	49
5.1	THz-Spectroscopy.....	49
5.2	Microwave Spectroscopy.....	51
5.2.1	Network Analyzer	53
5.2.2	Microwave Technology.....	54
5.2.3	THz-Applications with Microwave Technology	55
5.3	Biochip Reader Setup.....	57
5.3.1	Hardware	57
5.3.2	Software Signal Processing	60
5.4	THz-Path Setup	62
5.4.1	Quasioptical Transmission Setup	62
5.4.2	Waveguide Setup	62
5.4.3	Hybrid Setup.....	63
5.5	Demonstrator Setup.....	64
6	Measurements and Results	67
6.1	Biochip Design.....	69
6.2	Thin-Film Sensing.....	71
6.3	DNA-Sensing.....	75
6.3.1	DNA-Functionalization.....	75
6.3.2	Successful dsDNA Measurement.....	77
6.3.3	Unsuccessful DNA Test Series.....	78
7	Conclusion	83
8	Appendix	87
8.1	Symbols and Abbreviations	87
8.2	FSS Designs	88
8.3	FSS on PET-foil	90
8.4	Biochip Production Logs.....	91
8.5	DNA-Handling Recipe.....	92
	Bibliography.....	95
	Permissions.....	102
	Danksagung.....	103