

Contents

1	Introduction	1
1.1	Technologies for 300-GHz Power Amplifiers	2
1.1.1	State of the Art of 300-GHz Power Amplifier Concepts	4
1.2	Goals and Outline of this Work	7
2	Analysis of Device Configurations and Thin-Film Transmission Lines	11
2.1	Metamorphic High-Electron-Mobility Transistor Technology	12
2.2	Concepts and Device Configurations for sub-mm-Wave Power Amplifiers	13
2.2.1	Parallel-Connected Power Amplifier Concepts	13
2.2.2	Series-Connected Power Amplifier Concepts	15
2.3	Thin-Film Transmission Lines for Compact sub-mm-Wave Power Amplifiers	18
2.3.1	Traditional Thin-Film Wiring	21
2.3.2	Air-Bridge Thin-Film Wiring	23
2.3.3	Thin-Film Transmission Lines with Structured Ground Metal . .	24
2.4	Discussion and Conclusion on Chapter 2	28
3	Analysis of InGaAs mHEMT Devices for Broadband 300-GHz Power Amplifiers	31
3.1	Recess Optimization for Increased Breakdown Voltage	31
3.1.1	Evaluation of Recess-Length Impact on DC and Small-Signal Device Figures	32
3.1.2	Large-Signal Performance Characterization and Considerations .	35
3.2	Evaluation and Modeling of Multi-Finger Devices	38
3.2.1	Impact of Feeding Structures and Layout Complexity	40
3.2.2	Modeling of Compact Multi-Finger Devices	43
3.2.3	Development of Compact Multi-Finger Cascode Devices	46
3.3	Comparison of Device Configurations	50
3.4	On-Chip Load Pull of mHEMT Devices at THz Frequencies	53
3.4.1	On-Chip Load-Pull Circuit Topology	54
3.4.2	On-Chip Load-Pull Characterization	56
3.5	Discussion and Conclusion on Chapter 3	61
4	Development of Compact 300-GHz Power Amplifier MMICs	63
4.1	Circuit-Simulation Approach	63
4.2	Development of a Compact 300-GHz PA Topology	66
4.2.1	300-GHz Cascode Amplifier Circuits	67
4.2.2	Chip-size Optimized 300-GHz Unit Amplifier	72

4.3	300-GHz Thin-Film Wilkinson Power Combiners	77
4.3.1	Layout Considerations for 300-GHz Thin-Film Wilkinson Power Combiners	80
4.4	300-GHz High-Power Amplifier MMICs	86
4.5	Discussion and Conclusion on Chapter 4	89
5	300-GHz Power Amplifier Waveguide Modules	93
5.1	Considerations for Via Placement in Compact THz MMICs	93
5.1.1	Experimental Investigation of Via Placement	96
5.1.2	Simulation of Via Placement in TFMSL Circuits	99
5.1.3	Conclusion	100
5.2	300-GHz Power Amplifier Waveguide Module	102
5.2.1	Measurement Results	103
5.3	Waveguide Power Combiner at 300-GHz	105
5.4	Two-Way Combined 300-GHz Power Amplifier	109
5.5	Discussion and Conclusion on Chapter 5	112
6	Conclusion and Discussion	115
A	300-GHz State-of-the-Art Power Amplifiers and On-Chip Combiners	119
A.1	300-GHz Power Amplifier MMICs	119
A.2	300-GHz Power Amplifier Modules	120
A.3	300-GHz On-Chip Combiners	120
B	Elevated-CPW and Slow-Wave Thin-Film Transmission Lines	123
B.1	Additional Information on the MET2MET3 ECPW	124
B.2	Additional Information on the MET3 ECPW	127
C	Modeling of Passive TFMSL Components	129
D	Waveguide to MMIC Transition	131
	Bibliography	133