

# Contents

<b>1</b>	<b>Introduction</b>	<b>11</b>
<b>2</b>	<b>Group-III-Nitrides and their Heterostructures</b>	<b>15</b>
2.1	Gallium Nitride . . . . .	15
2.1.1	Lattice Properties . . . . .	15
2.1.2	Electrical and Thermal Material Properties . . . . .	17
2.2	Gallium Nitride for Microwave Applications . . . . .	19
2.3	Properties of AlGaN/GaN Heterostructures . . . . .	20
<b>3</b>	<b>Basic Physics and Modelling of AlGaN/GaN HEMTs</b>	<b>25</b>
3.1	Fundamental Current-Voltage Characteristics . . . . .	25
3.1.1	Pinch-off Voltage . . . . .	26
3.1.2	Drain Channel Current . . . . .	29
3.2	Physical Device Modelling . . . . .	34
3.2.1	Electro-Thermal DC Model . . . . .	34
3.2.2	Sub-Threshold DC Model . . . . .	43
3.2.3	Small-Signal RF Model . . . . .	44
<b>4</b>	<b>Impact of Non-Idealities on Device Performance</b>	<b>49</b>
4.1	Trapping Effects and Dispersion . . . . .	49
4.1.1	Influence of Dispersion on RF Power Performance . . . . .	50
4.1.2	Traps as the Root Cause of Dispersion . . . . .	52
4.1.3	Transconductance Dispersion and its Impact on Linearity . . . . .	56
4.2	Leakage Currents . . . . .	61
4.2.1	Schottky Diode Leakage . . . . .	63
4.2.2	Transistor Leakage . . . . .	68
4.2.3	Silicon Nitride Passivation Layer Analysis . . . . .	73

4.3	Self-Heating . . . . .	77
4.3.1	Thermal Resistance . . . . .	77
4.3.2	Field-Dependent Self-Heating Effects . . . . .	78
<b>5</b>	<b>Technology Aspects for RF Performance Improvement</b>	<b>85</b>
5.1	Simulation Study . . . . .	85
5.2	Experimental Results . . . . .	90
5.3	Limitations . . . . .	90
<b>6</b>	<b>Summary and Conclusion</b>	<b>95</b>
	<b>Bibliography</b>	<b>99</b>
<b>A</b>	<b>List of Acronyms and Symbols</b>	<b>109</b>
<b>B</b>	<b>Process Sequence</b>	<b>113</b>
	<b>Publications</b>	<b>121</b>
	<b>Curriculum Vitae</b>	<b>123</b>