

Contents

Nomenclature	13
Acronyms	19
1. Introduction	21
1.1. General Lighting and its Savings Potential	21
1.2. Current Issues in LED Research	23
1.3. The Nanowire Approach	25
1.4. Physics-Based Simulation	27
1.5. Contents	28
2. Outline of Semiconductor Physics	29
2.1. Energy Bands and Carrier Statistics	29
2.2. Carrier Transport	34
2.3. Quantum Mechanics	39
2.4. QUATRA/CELS: a Multi-Physics Simulation Framework	43
3. Simulation Models for III-Nitride Devices	47
3.1. Properties of Wurtzite Crystals	47
3.2. Orientation Dependency of Strain	49
3.3. Orientation Dependency of Polarization Effects	55
3.4. Strained Wurtzite 6x6-Hamiltonian for Arbitrary Crystal Orientations	59
3.5. Alternative Auger-Models for Quantum Wells	65
4. Increasing Internal Efficiency: The Core-Shell Approach	71
4.1. Physical Structure	71
4.2. Benchmark Geometry	73
4.3. Active Area Increase	74
4.4. Study of a Top-Contacted Core-Shell-Nanowire	75
4.5. Impact of Alternative Contact Arrangements	79
4.6. Optimisation Model	82
4.7. Optimisation of the Shell Thickness	83
4.8. Optimisation of the Aspect Ratio	86
4.9. Conclusion	90

5. Monolithic White LEDs without Phosphor Conversion	93
5.1. Overview of Nanowire Designs	94
5.2. Strain Relations of Nanowires with Thick Active Layers	95
5.3. Study of a White Nanowire Bulk LED	98
5.4. Optimisation of Nanowire Bulk LEDs	103
5.5. White Multi Quantum Disk Structures	109
5.6. Conclusion	116
6. Conclusions	119
6.1. Comparison between Different LED Designs	119
6.2. Major Achievements	120
6.3. Outlook and Future Work	121
6.4. A not too Scientific Epilogue	122
Bibliography	123
A. Simulation Parameters	131
Index	136