Contents

Preface vii

Chapter 1. State-of-the-Art of Infrared Technology 1

1.1. Introduction 1
1.2. Compound materials III-V 2
1.2.1. Historical introduction 2
1.2.2. Physical properties of the III-V compounds emission 4
1.2.3. Ternary and quaternary compounds 18
1.3. Light-emitting diodes 21
1.3.1. Introduction 21
1.3.2. Epitaxial structures 22
1.3.3. LED assembly 32
1.4. Applications 38
1.4.1. Infrared remote control systems 38
1.4.2. Autofocus 40
1.4.3. Space 42
1.5. Conclusion 44

Chapter 2. Analysis and Models of an LED 45

2.1. Introduction 45
2.2. Physicochemical analysis 46
2.2.1. Context and objectives 46
2.2.2. Analysis adapted to casing 46
2.2.3. Analysis adapted to the chip 52
2.3. Electro-optical analysis 56
2.3.1. Current–voltage characteristics 57
2.3.2. Spectral characteristics 60

2.4. Initial characterizations of 935 nm LEDs 68
2.4.1. Technological evaluation 68
2.4.2. Electro-optical characterization and electrical modeling of the LED 70
2.5. Conclusion 78

Chapter 3. Physics of Failure Principles 79

3.1. Introduction 79
3.2. Aging tests 80
3.2.1. Sequence of aging campaign 80
3.3. Failure signatures 86
3.3.1. Functional parameters 86
3.3.2. Electrical failure signatures 88
3.3.3. Optical failure signatures 93
3.4. Physics of failures 95
3.4.1. Mechanisms related to transport phenomena 95
3.4.2. Electron transition mechanisms 110
3.4.3. Model of a defect in a crystal 113
3.4.4. Impact of defects on emission properties 114
3.5. Conclusion 115

Chapter 4. Methodologies of Reliability Analysis 117

4.1. Introduction 117
4.2. Method based on the physics of failures 118
4.2.1. Acceleration and aggravation factor 118
4.2.2. Estimation of lifetime distribution 121
4.2.3. Line input sorting of a component 124
4.3. Digital methods 127
4.3.1. General points 127
4.3.2. Application: cases of emissive optoelectronic systems 128
4.3.3. Conclusions 130
4.4. A new approach 131
4.4.1. Context and method 131
4.4.2. LEDs studied 131
4.4.3. Gamma irradiation 149
4.4.4. Neutron irradiation 153
4.5. Conclusion 159

Bibliography 161

Index 163