

Contents

1 Overview of Organic Semiconductors

- 1.1 Organic Semiconductors
- 1.2 Excitons
 - 1.2.1 Singlets and Triplets
 - 1.2.2 Electronic Transitions
 - 1.2.3 Quenching Processes
 - 1.2.4 PL efficiency
- 1.3 Charge Transport

2 Organic Light-Emitting Devices

- 2.1 Architecture and Basic Operation
 - 2.1.1 Efficiency Components
- 2.2 Fabrication Processes
- 2.3 Characterization
 - 2.3.1 Current Voltage and Luminance
 - 2.3.2 Efficiency
 - 2.3.3 Chromaticity
 - 2.3.3.1 RGB
- 2.4 Historical Development
 - 2.4.1 The First OLEDs
 - 2.4.2 Phosphorescence
 - 2.4.3 Thermally Activated Delayed Fluorescence
- 2.5 Efficiency Roll-Off
- 2.6 Recombination Zone Characterization
- 2.7 Single Carrier Devices
- 2.8 Operational Lifetime
 - 2.8.1 Degradation Mechanisms
 - 2.8.1.1 External: Dark Spots and Delamination
 - 2.8.1.2 Exciton and Polaron
 - 2.8.1.3 Interfaces
 - 2.8.2 Luminance Scaling

- 2.8.3 Analysis Techniques
 - 2.8.3.1 Chemical Analysis
 - 2.8.3.2 Modeling
 - 2.8.3.3 Spectral Characterization

3 Transient and Steady-State Dynamics

- 3.1 Motivation
- 3.2 Theory
 - 3.2.1 Exciton Dynamics
- 3.3 Polaron Dynamics
 - 3.3.1 Transient Electroluminescence
 - 3.3.2 Efficiency Analysis
- 3.4 Experimental Details
- 3.5 Exciton Quenching in Photoluminescence
- 3.6 Application to Devices
 - 3.6.1 Quenching Only Steady-State Fit
 - 3.6.2 Transient Modeling
 - 3.6.3 Transient Term Efficiency
 - 3.6.4 Extracting Exciton Formation Efficiency
 - 3.6.5 Drift Model
- 3.7 Understanding Assumptions of Polaron Model
 - 3.7.1 Carrier Injection
 - 3.7.2 Charge Imbalance
- 3.8 Conclusion

4 Integrated Photoluminescence Lifetimes

- 4.1 Luminance as Efficiency Loss
- 4.2 Photoluminescence Characterization
 - 4.2.1 Light Selection
 - 4.2.2 Absorption - Recombination Overlap
 - 4.2.3 Contact Degradation
 - 4.2.4 Quenching Changes During Degradation
 - 4.2.5 Verification with Exciton Lifetime
- 4.3 Experimental Implementation

- 4.3.1 Motivation
- 4.3.2 Development
- 4.3.3 Hardware Setup
- 4.3.4 Software Development

4.4 Conclusion

5 Applied Integrated Lifetimes

- 5.1 CBP Host Thickness
 - 5.1.1 Motivation and Experimental
 - 5.1.2 Results
 - 5.1.3 Conclusion
- 5.2 MEML Luminance Scaling
 - 5.2.1 Motivation
 - 5.2.2 Experimental
 - 5.2.3 Results
 - 5.2.4 Conclusion
- 5.3 Dow Cohost
- 5.4 NPD Study

6 Novel Blue Emitter Developement

- 6.1 Molecular Systems
- 6.2 Performance Optimization
- 6.3 Solution Molecular Aggregation

7 Data Management for Devices

8 Modeling Out-Coupling

- 8.1 Theory
- 8.2 Recombination Zone Overlap During Lifetime

9 Future Research

Bibliography

Appendices

A List of Publications

B Measuring Triplet Energies

C Single Carrier Device Modeling

C.1 Future Work

D Out-Coupling Code

D.1 Transfer Matrix Model

D.2 Out-Coupling (Power Dissipation)

E Lifetime Box Code

F Chemical Structures

G Material Properties

List of Figures

List of Tables