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Time-resolved Transient  
Electroluminescence Measurements of  
Organic Light Emitting Devices (OLEDs)  
有機發光器件的時間分解瞬態電致發光測  
量

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## Abstract

Time-resolved transient electroluminescence (TRTEL) method was used to study the lag time of the electroluminescent (EL) response of single-layer N,N'-bis-(1-naphthyl)-N,N'-diphenyl-1,1'-biphenyl-4,4'-diamine (NPB) and double-layer NPB/tris-(8-hydroxyquinoline)-aluminum ( $\text{Alq}_3$ ) organic light-emitting devices (OLEDs) excited by a voltage pulse. Double-layer NPB/ $\text{Alq}_3$  OLEDs with different emitting area and  $\text{Alq}_3$  thickness were investigated. The EL delay time was employed to determine the field-dependent hole and electron drift mobility of NPB and  $\text{Alq}_3$ , respectively. From the thickness-dependent mobility measurements, we assume that the internal electric field after excitation by voltage pulse is predominantly and homogeneously distributed over both the layers in double-layer devices. Furthermore, the measurements showed that the active area and resistance-capacitance (RC) time constant of OLEDs limit time response primarily in high electric field. It was supported by simple mobility calculations based on monoexponential voltage growth inside the device after the excitation by the rectangular voltage pulse. This study elucidates the importance of geometrical configuration and RC time constant of the device, which may be the limiting factors together with the external electronic circuitry in determining the electronic/optical properties of organic layers.

In addition, double-layer organic light-emitting devices (OLEDs) using NPB ( $\alpha$ -naphthylphenylbiphenyl diamine) as the hole-transport layer and DCM [4-(dicyanomethylene)- 2-methyl-6-(p-dimethylaminostyryl)-4H-pyran] doped  $\text{Alq}_3$  [tris-(8-hydroxyquinoline)] as the electron-transport and emission layer were studied using a time-resolved transient electroluminescence method. Upon

application of a pseudo-rectangular voltage pulse, the luminance increased and overshot to maxima and then decreased to steady values. Using suitable spectrum filters to separate the emission from the  $\text{Alq}_3$  host and the DCM guest, the overshoot luminance peaks were identified to originate solely from the DCM emission. However, when the same devices were operated by two consecutive pseudo-rectangular voltage pulses, the overshoot luminance peaks vanished during the second pulse if time gap between the two voltage pulses is shorter than 1 ms. The overshoot was considered to be related to carrier traps in the DCM molecules. The present work not only reveals the physical mechanisms of the luminance overshoot in OLEDs, but also highlights its potential implications in the applications of dopant emitting OLEDs for motion picture display.

## **Table of Contents:**

**Abstract**

**Certification of approval by the panel of examiners**

**Acknowledgment**

**Table of contents**

**List of figures**

**Acronyms**

**Objectives**

<b>Chapter 1. Literature review</b>	<b>1</b>
<b>1.1 Introduction into organic light-emitting devices and time-resolved electroluminescence measurement</b>	<b>1</b>
<b>1.2 Organic materials used in electroluminescence devices</b>	<b>4</b>
<b>1.3 OLED configuration and features</b>	<b>5</b>
<b>1.4 Electroluminescence from organic materials</b>	<b>8</b>
<b>1.5 Carrier injection</b>	<b>9</b>
<b>1.5.1 Energy level alignment</b>	<b>9</b>
<b>1.5.2 Electrodes used in organic electroluminescence devices</b>	<b>10</b>
<b>1.5.3 Carrier transport</b>	<b>12</b>
<b>1.5.4 Energy levels</b>	<b>13</b>
<b>1.6 Quantum efficiency of electroluminescence organic devices</b>	<b>14</b>
<b>1.7 Phosphorescence induced in organic electroluminescence devices</b>	<b>18</b>

<b>1.8 Dopants in the matrices of organic electroluminescence materials</b>	<b>19</b>
<b>1.9 Excitons</b>	<b>22</b>
<b>1.10 Energy Transfer</b>	<b>23</b>
<b>1.11 Simple structures and function of organic electroluminescence devices</b>	<b>27</b>
<b>1.12 Carrier mobility in organic electroluminescence materials</b>	<b>28</b>
<b>Chapter 2. Fabrication and Characterization of OLEDs</b>	<b>34</b>
<b>2.1 OLED Fabrication</b>	<b>34</b>
<b>2.2 Characterization of OLEDs</b>	<b>38</b>
<b>2.2.1 Current-Voltage and Luminance-Voltage Measurements</b>	<b>38</b>
<b>2.2.2 Mobility Measurement in Organic Materials for OLED Construction</b>	<b>40</b>
<b>Chapter 3. Effect of the Alq<sub>3</sub> layers geometry and RC time constant on the time-resolved transient electroluminescence</b>	<b>51</b>
<b>3.1 Importance of organic electroluminescent devices geometry</b>	<b>51</b>
<b>3.2 Experimental in time-resolved transient electroluminescence measurements of different OLED structures</b>	<b>53</b>
<b>3.3 Behavior of OLED structures at the time-resolved</b>	<b>54</b>

**transient electroluminescence measurement and  
implication**

<b>3.4 Conclusion remarks to the time-resolved transient electroluminescence measurements</b>	<b>65</b>
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<b>Chapter 4. Time resolved electroluminescence induced in</b>	<b>71</b>
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**Alq<sub>3</sub> layer doped with DCM**

<b>4.1 Discovery of overshoot effect in DCM-doped organic electroluminescent devices</b>	<b>71</b>
<b>4.2 Experimental details of DCM-doped devices</b>	<b>72</b>
<b>4.3 The origins of overshoot in transient response of DCM-doped devices and implication</b>	<b>72</b>

<b>Appendix. Publications</b>	<b>87</b>
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## List of figures

Fig.1.1. The chemical structures of some common functional materials in OLEDs.

Fig.1.2. In single-layer device a), the only organic layer serves as hole transport, electron transport and emissive layer. In double-layer device b), one of the organic layer serves as hole transport layer while the another one serves as both electron transport layer and emission layer.

Fig.1.3. Equivalent circuits and schematic energy-level diagrams for single-layer (a) and double-layer (b) devices.

Fig. 1.4. The energy level alignment of organic–metal interface with (a) and without (b) dipole barrier.

Fig. 1.5. Energy levels of a standard device (ITO/NPB/Alq/MgAg).

Fig. 1.6. Fraction of excited singlet and triplet formation after electron-hole recombination process.

Fig. 1.7. Energy level diagram of an electrophosphorescent device with a CBP luminescent layer doped with PtOEP.

Fig. 1.8. The chemical structural formulas of coumarin 6, DCJT, rubrene and DCM dopants used in OLEDs.

Fig. 1.9. Schematic diagrams of a (a) Frenkel exciton, (b) Wannier-Mott exciton and (c) Charge-transfer exciton.

Fig. 1.10. The schematic diagram of the (a) Forster singlet-singlet energy transfer, (b) Dexter singlet-singlet energy transfer and (c) Dexter triplet-triplet energy transfer.

Fig. 2.1. The fabrication procedures of a) conventional OLED for routine measurement and b) specially-patterned OLED for TRTEL measurement.

Fig. 2.2. The simplified diagram of a vacuum chamber for OLED fabrication.

Fig. 2.3. The schematic diagram of current-voltage and luminance-voltage measurements of OLED. The computer (a) controls the measured voltage range and ramping voltage, (b) records the electric current and (c) the luminance data supplied by the optical spectrometer in each step of ramping voltage on the OLED device.

Fig. 2.4. The schematic diagram of Time-Of-Flight (TOF) measurement.

Fig. 2.5. The photocurrent signal captured in TOF measurement of dispersive and non-dispersive organic materials.

Fig. 2.6. (a) The simplified diagram of the experimental setup of TRTEL measurement and (b) the method of determining the delay time  $t_d$ .

Fig. 2.7. The recombination zone in (a) single-layer device and (b) double-layer device.

Fig. 3.1 depicts transient electroluminescence response of single-layer NPB device on voltage pulse of 18 V. The inset shows dependence of delay time versus the electric field.

Fig. 3.2. The enlarged view of typical voltage pulse applied and determination of the delay time  $t_d$  from transient EL outline. Open circles and close circles are rough data as measured and smooth data using FFT filtering, respectively.

Fig. 3.3. Transient EL response to different amplitude and duration of voltage pulses as collected from a double-layer NPB(60nm)/Alq<sub>3</sub>(60nm) OLED.

Fig. 3.4. Electric field dependence of apparent electron mobility in double-layer devices with the 60 nm thick NPB film and variable thickness of Alq<sub>3</sub> films (60 nm - square; 90 nm - up triangle, and 120 nm – circle) For reference, apparent hole mobility of the 240 nm NPB single-layer device (down triangle) is plotted.

Fig. 3.5. Transient behavior of the double-layer NPB(60nm)/Alq<sub>3</sub>(60nm) OLEDs with different active areas (0.5 mm<sup>2</sup> and 4 mm<sup>2</sup> - prepared simultaneously under the same conditions) at different voltages (4 V, and 10 V).

Fig. 3.6. Electric field dependence of apparent electron mobility in double-layer devices with 60 nm thick NPB film and 60 nm (square) and 120 nm (circle) thick  $\text{Alq}_3$  film. The close symbols correspond to the  $0.5 \text{ mm}^2$  area device whereas the open symbols represent the measurement on the device with area  $4\text{mm}^2$ .

Fig. 3.7. The close symbol depicts the simulated data for the setup with different RC constants. The open symbols illustrate rough data as measured. The full line represents the reference ideal case when RC constant is equal to zero.

Fig. 3.8. Comparison of the apparent electron mobility as measured with TOF and TRTEL data compiled from the data previously published [5-9, 18-20].

Fig. 4.1. Schematic diagrams of solvatochromism are shown. When the excited state dipole moment  $\mu_1$  larger than the ground state moment  $\mu_0$  as a function of solvent molecule dipole moment (solvent polarity), a decrease in the luminescence energy of molecules is observed as shown in (a) whereas the case of  $\mu_0$  larger than  $\mu_1$  is shown in (b).

Fig. 4.2. The emission spectrum of different concentrations of DCM-doped  $\text{Alq}_3$  film.

Fig. 4.3. The typical transient EL response of two devices consisting of NPB/ $\text{Alq}_3$  and NPB/( $\text{Alq}_3$ : 1% DCM) on 13 V pulse voltage with the 5  $\mu\text{s}$  duration.

Fig. 4.4. The transient EL response of 1 % DCM-doped device using double-pulse at different voltage amplitude.

Fig. 4.5. The double pulse TRTEL measurement on 1 % DCM-doped  $\text{Alq}_3$  using 500 nm band pass filter.

Fig. 4.6. The double pulse TRTEL measurement on an OLED system employing  $\text{Alq}_3$  layer doped with 1 % DCM obtained with using 650 nm high pass filter.

Fig. 4.7. The transient EL response during the second pulse at different delay time in double pulse TRTEL measurements.

Fig. 4.8. The overshoot effect obtained in TRTEL measurements of different DCM concentrations in  $\text{Alq}_3$ . The overshoot increase as the DCM doping in  $\text{Alq}_3$  increases from 0 to 2 % , but then diminishes at higher concentrations.