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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 (Alq_3) organic light-emitting devices (OLEDs) excited by a voltage pulse. Double-layer NPB/Alq_3 OLEDs with different emitting area and Alq_3 thickness were investigated. The EL delay time was employed to determine the field-dependent hole and electron drift mobility of NPB and 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 (α-naphthylphenylbiphenyl diamine) as the hole-transport layer and DCM [4-(dicyanomethylene)- 2-methyl-6-(p-dimethylaminostyryl)-4H-pyran] doped 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 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.

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