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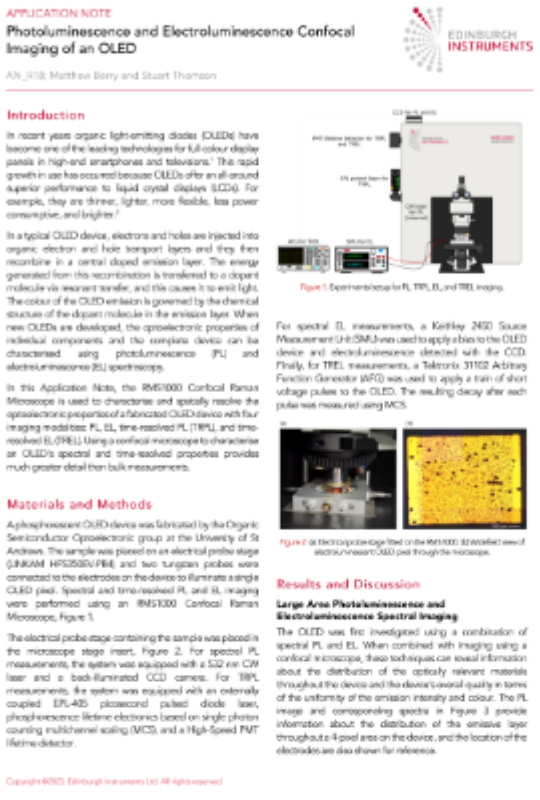

APPLICATION NOTE

Photoluminescence and Electroluminescence Confocal Imaging of an OLED

EDINBURGH INSTRUMENTS

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Introduction

In recent years organic light-emitting diodes (OLEDs) have become one of the leading technologies for full-colour display panels in high-end smartphones and televisions.[1] This rapid growth in use has occurred because OLEDs offer an all-around superior performance to liquid crystal displays (LCDs). For example, they are thinner, lighter, more flexible, less power consumptive, and brighter.[2]

In a typical OLED device, electrons and holes are injected into organic electron and hole transport layers and they then recombine in a central doped emission layer. The energy generated from this recombination is transferred to a dopant molecule via resonant transfer, and this causes it to emit light. The colour of the OLED emission is governed by the chemical structure of the dopant molecule in the emission layer. When new OLEDs are developed, the optoelectronic properties of individual components and the complete device can be characterised using photoluminescence (PL) and electroluminescence (EL) spectroscopy.

In this Application Note, the RMS1000 Confocal Raman Microscope is used to characterise and spatially resolve the optoelectronic properties of a fabricated OLED device with four imaging modalities: PL, EL, time-resolved PL (TRPL), and time-resolved EL (TREL). Using a confocal microscope to characterise an OLED's spectral and time-resolved properties provides much greater detail than bulk measurements.

Materials and Methods

A phosphorescent OLED device was fabricated by the Organic Semiconductor Optoelectronic group at the University of St Andrews. The sample was placed on an electrical probe stage (LINKAM HPS350V-PB4) and two tungsten probes were connected to the electrodes on the device to illuminate a single OLED pixel. Spectral and time-resolved PL and EL imaging were performed using an RMS1000 Confocal Raman Microscope, Figure 1.

The electrical probe stage containing the sample was placed in the microscope stage insert, Figure 2. For spectral PL measurements, the system was equipped with a 532 nm CW laser and a back-illuminated CCD camera. For TRPL measurements, the system was equipped with an externally coupled EPL-405 picosecond pulsed diode laser, photoluminescence lifetime electronics based on single photon counting multichannel scaling (MCS), and a High-Speed PMT lifetime detector.

Figure 1. Experimental setup for PL, TRPL, EL, and TREL imaging.

For spectral EL measurements, a Keithley 2450 Source Measurement Unit (SMU) was used to apply a bias to the OLED device and electroluminescence detected with the CCD. Finally, for TREL measurements, a Tektronix 31102 Arbitrary Function Generator (AFG) was used to apply a train of short voltage pulses to the OLED. The resulting decay after each pulse was measured using MCS.

Figure 2. (a) Electrical probe stage fitted on the RMS1000. (b) Modified view of electroluminescent OLED pixel through the microscope.

Results and Discussion

Large Area Photoluminescence and Electroluminescence Spectral Imaging

The OLED was first investigated using a combination of spectral PL and EL. When combined with imaging using a confocal microscope, these techniques can reveal information about the distribution of the optically relevant materials throughout the device and the device's overall quality in terms of the uniformity of the emission intensity and colour. The PL image and corresponding spectra in Figure 3 provide information about the distribution of the emissive layer throughout a 4-pixel area on the device, and the location of the electrodes are also shown for reference.

Photoluminescence and Electroluminescence Confocal Imaging of an OLED

The optoelectronic properties of an OLED device are mapped using an RMS1000 Confocal Raman Microscope in spectral and time-resolved photoluminescence and electroluminescence imaging modes. These techniques enable the characterization of the OLED in much greater detail than is possible with bulk measurements.

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