TOPICS

Efficient Orange Organic Light-Emitting Diodes Doped with Coumarin Dyes

Hisayoshi Fujikawa, Special Research Lab. 1

クマリン色素を用いた高効率橙発光の有機EL素子

第1特別研究室　藤川久喜

Organic light-emitting diodes (OLEDs) have received much attention in recent years because of the potential application of such emitters to flat panel displays. For white color display and backlight applications, it is necessary to develop a set of blue and orange OLEDs with sufficiently high luminous efficiency and suitable chromaticity. For orange OLEDs, DCJT, an orange fluorescent laser dye, has been widely used as a dopant for a host *Tris* (8-hydroxyquinolinato) aluminum (Alq_3) layer.[1)] However, the efficiency of orange OLEDs is very low, presenting a serious obstacle to development. In this study, new orange fluorescent dyes based on coumarin, which has high fluorescence yield and chemical stability, have been synthesized. We show that the efficiency of orange OLEDs is successfully improved using these coumarin dyes[2)].

Four kinds of coumarin dyes with orange fluorescence peak wavelengths of 570 to 600 nm were synthesized. The molecular structures are illustrated in **Fig. 1**, with the structure of DCJT shown for comparison. Five kinds of OLEDs with the structure indium-tin-oxide (150 nm) / TPTE (triphenylamine tetramer, 60 nm) / dye (1%) - doped Alq_3 (20 nm) / Alq_3(40 nm) / LiF (0.5 nm) / Al (150 nm) were fabricated on glass substrates by vacuum deposition, and the electro-luminescence (EL) properties were measured.

Figure 2 shows the EL spectra for the five devices at a current density of 11 mA/cm^2. The EL spectra include peaks at 570 to 600 nm, similar to the corresponding photoluminescence (PL) spectra of these dyes when dissolved in an organic solvent. A shoulder assigned to green light emitted by Alq_3 (500 nm) is also seen in the spectrum for the NKX2241 device, while the NKX2220, NKX2221, and NKX2222 devices exhibit strong pure-orange emissions, reflected in the EL spectra by a reduction in the Alq_3 emission. The NKX2220, NKX2221, and NKX2222 devices also exhibit high photometric efficiencies of 3.8 to 4.8 cd/A, high external quantum efficiencies of 1.6 to 1.7%, and pure-orange color coordinates of x = 0.46-0.51, y = 0.46-0.51, as summarized in **Table 1**. The photometric efficiencies are much higher than for conventional orange-emitting devices based on DCJT dye. The emission spectrum of the host Alq_3 overlapped the absorption spectra of these coumarin dyes, suggesting the noteworthy possibility of efficient Förster energy transfer in coumarin-doped Alq_3.

These results show that coumarin dyes are promising high-efficiency orange dopants. Other coumarin dyes have also been found act as a guest dopant for green and blue emissions, and the EL properties of OLEDs using these dyes will be reported in the near future. The coumarin dyes examined here were developed in cooperation with Hayashibara Biochemical Laboratories, Inc., Okayama, Japan.

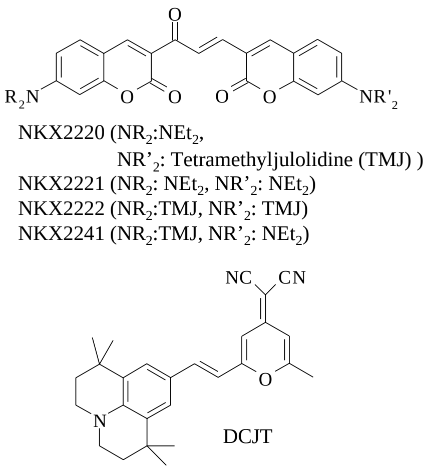

Fig. 1 Molecular structures of new coumarin dyes and conventional DCJT dye.

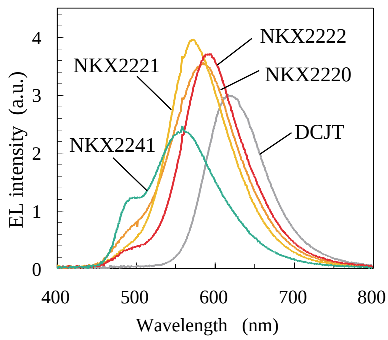

Fig. 2 EL Spectra of OLEDs with orange dopants.

Table 1 Photometric efficiencies, external quantum efficiencies, and CIE color coordinates for OLEDs with orange dopants.

	Photometric Eff. (cd/A)	Ext. Quantum Eff.	CIE color coordinate
NKX2220	4.5	1.7	(0.46, 0.48)
NKX2221	4.8	1.6	(0.46, 0.51)
NKX2222	3.8	1.6	(0.51, 0.46)
NKX2241	3.4	1.1	(0.40, 0.52)
DCJT	1.7	1.2	(0.62, 0.37)

References

1) Tang, C. W., et al. : J. Appl. Phys., **65**-9(1989), 3610
2) Satsuki, M., et al. : Extended Abstracts (The 48th Spring Meet.) ; Jpn. Soc. of Appl. Phy. and Related Soc., (2001), 1291

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