



Synthesis and electroluminescent properties of anthracene derivatives containing electron-withdrawing oxide moieties



Jhin-yeong Yoon^a, Eun Jae Na^a, Soo Na Park^a, Seok Jae Lee^b, Young Kwan Kim^{b,*},
Seung Soo Yoon^{a,*}

^a Department of Chemistry, Sungkyunkwan University, Suwon, 440-746, Republic of Korea

^b Department of Information Display, Hongik University, Seoul, 121-791, Republic of Korea

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ABSTRACT

A series of new blue-emitting materials: (4-(10-(naphthalen-2-yl)anthracen-9-yl)phenyl)(phenyl)methanone (**1**); 9-(naphthalen-2-yl)-10-(4-((diphenyl)phosphine oxide)phenyl)anthracene (**2**); 9-(naphthalen-2-yl)-10-(4-(phenylsulfonyl)phenyl)anthracene (**3**) were designed and synthesized via Suzuki cross-coupling reaction. Multilayer OLEDs were fabricated in the following sequence: ITO (180 nm)/NPB (50 nm)/blue materials **1–3** (30 nm)/TPBi (15 nm)/LiQ (2 nm)/Al (100 nm). All devices showed the efficient blue EL emissions. In particular, the device using **1** as an emitter exhibited efficient blue electroluminescent properties with a maximum luminous, power, external quantum efficiency and CIE coordinates of 0.36 cd/A, 0.90 lm/W, 0.55% at 20 mA/cm² and (*x* = 0.16, *y* = 0.20) at 10.0 V, respectively.

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1. Introduction

Organic light-emitting devices (OLEDs) have been widely studied in the past two decades for use in flat panel displays and more-efficient lighting products [1]. For the practical applications, three primary color emitters that have high emission efficiency and high color purity are required. However, because of the wide band-gap of blue emitters, blue OLEDs show relatively poorer performance than red and green OLEDs. For this reason, the progress in highly efficient blue-light emitters with good color purity is a great challenge. Up to now, various blue emitters have been developed by many research groups [2–6]. However, the EL performances of blue emitters still need to be improved.

In this work, a series of new blue fluorescent material based on 9-naphthylanthracene core unit containing various electron-withdrawing oxide moieties were synthesized and their electroluminescent properties were investigated. The electron-withdrawing oxide moieties in the emitting materials were introduced to tune the HOMO or LUMO energy levels of the emitting materials, and to enhance the EL performances [7–8].

2. Experimental details

2.1. Material preparation and characterization

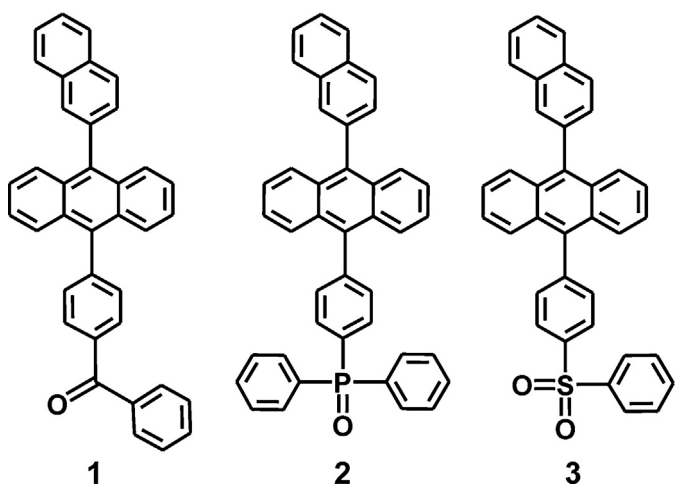
The molecular structure and synthetic route of **1–3** compounds are outlined in Scheme 1. General procedure for the Suzuki cross-coupling reaction: the corresponding hetero aryl bromide (1.0 mol), 10-(naphthalen-2-yl)anthracene-9-ylboronic acid (1.2 mol) and Pd(PPh₃)₄ (0.04 mol) were mixed in a solution of aqueous 2.0 M Na₂CO₃ (10.0 mol), ethanol and toluene. The mixture was refluxed at 90 °C for 2 h. After the reaction had finished, the reaction mixture was extracted with toluene and washed with water. The organic layer was dried with anhydrous MgSO₄ and filtered with charcoal. The solution was then evaporated. The crude product was purified by column chromatography with silica gel and subsequent recrystallization from THF/MeOH and then hot hexane filter.

(4-(10-(naphthalen-2-yl)anthracen-9-yl)phenyl)(phenyl)methanone (**1**): (yield = 83%). ¹H NMR (300 MHz, CDCl₃): δ [ppm]: 8.10–8.07 (m, 3H), 8.04–7.97 (m, 4H), 7.93–7.90 (m, 1H), 7.75 (t, *J* = 7.8 Hz, 4H), 7.66–7.63 (m, 3H), 7.61 (t, *J* = 1.8 Hz, 1H), 7.59–7.56 (m, 4H), 7.40–7.29 (m, 4H). IR (ATR): ν [cm⁻¹]: 3055, 2954, 2892, 2831, 1810, 1695, 1658, 1601, 1508, 1442, 1395, 1310, 1279, 1176, 1144, 1016, 1023, 960, 931, 905, 847, 822, 796, 762, 699. APCI-MS (*m/z*): 485 [M⁺].

9-(naphthalen-2-yl)-10-(4-((diphenyl)phosphine oxide)phenyl)anthracene (**2**): (yield = 81%). ¹H NMR (300 MHz, CDCl₃): δ [ppm]: 8.0 (d, *J* = 8.4 Hz, 1H), 8.04–8.01 (m, 1H), 7.7 (s, 1H), 7.4–7.82 (m, 7H), 7.74 (dd, *J* = 1.2, 7.5 Hz, 2H), 7.66–7.53 (m, 13H), 7.3–7.28 (m,

* Corresponding authors. Tel.: + 82 31 290 7071, 2 3142 3750; fax: +82 31 290 7075, 2 3141 8928.

E-mail addresses: kimykw@wongik.ac.kr (Y.K. Kim), ssyoon@skku.edu (S.S. Yoon).



Scheme 1. Structures of blue fluorescent materials 1–3.

4H). IR(ATR): ν [cm^{-1}]: 3051, 281, 2828, 1814, 162, 158, 1502, 143, 135, 1270, 111, 1117, 1022, 65, 35, 06, 823, 72, 756, 68. APCI-MS (m/z): 581 [M^+].

9-(naphthalen-2-yl)-10-(4-(phenylsulfonyl)phenyl)anthracene (3): (yield = 78%). ^1H NMR (300 MHz, CDCl_3): δ [ppm]: 8.21(d, $J=8.7$ Hz, 2H), 8.15(dd, $J=1.5, 8.1$ Hz, 2H), 8.08(d, $J=8.4$ Hz, 1H), 8.04–8.00(m, 1H), 7.5(s, 1H), 7.2–7.8(m, 1H), 7.73–7.70(m, 2H), 7.67–7.65(m, 3H), 7.62–7.58(m, 4H), 7.56–7.51(m, 3H), 7.36–7.27(m, 4H). IR(ATR): ν [cm^{-1}]: 3053, 280, 2831, 1813, 162, 155, 1501, 1443, 137, 1311, 1180, 1154, 1105, 1072, 1021, 68, 36, 88, 844, 81, 76, 768, 744, 715, 687, 664. APCI-MS (m/z): 521 [M^+].

2.2. Device fabrication and characterization

All organic materials and metals were deposited under high vacuum (5×10^{-6} Torr) using HS-1000 of DOV corp. The OLEDs were fabricated in the following sequence: ITO (180 nm)/4,4'-bis(*N*-(1-naphthyl)-*N*-phenyl amino)biphenyl (NPB, HTL) (50 nm)/blue

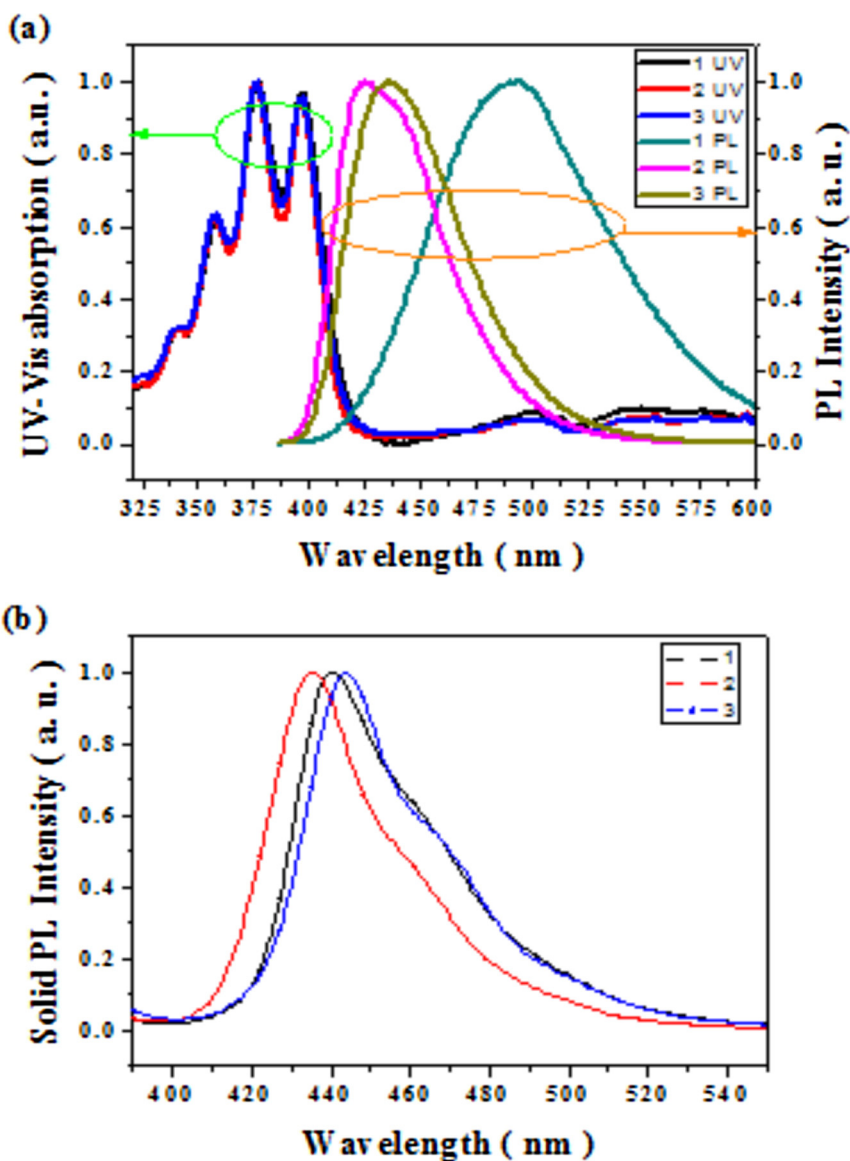


Fig. 1. (a) UV-vis absorption spectra, PL spectra in dichloromethane and (b) solid-state of blue emitters 1–3.

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