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Characterization of optoelectronic devices based on the methylene-linked compounds of pyrene

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[**Introduction**] Organic light-emitting diodes (OLEDs) and organic light emitting field effect transistor (OLEFET) have been identified as dominant technology after the breakthrough made by Tang and VanSlyke[1] and A. Hepp[2] for the applications of future optoelectronic devices. Although pyrene is the blue-emitting chromophore, investigation focused on using methylene-linked compounds of pyrene, i.e., pyrene-$(CH_2)_n$-pyrene, where n = 1, 2, 3, 4, 5, as emitters for OLEDs is very limited. On the contrary, the electron-transfer process and carrier mobility of electron and/or hole are different in the pyrene-$(CH_2)_n$-pyrene and unsubstituted pyrene, because the intermolecular and intramolecular electron-transfer process and carrier mobility are different.[3] The efficacy of inducing enhanced carrier mobility in a short linkage of methylene chain is very high.[3] Therefore, the electron-transfer process and carrier mobility in pyrene-$(CH_2)_n$-pyrene through the methylene bond might have the significant impact for increasing the performance of molecular devices. In the present study, we fabricate the OLED and OLEFET using pyrene-$(CH_2)_n$-pyrene compounds to investigate the electroluminescence dependence depending on the methylene chain length variation, and the fundamental role of the methylene chain length on the performance of the molecular devices.

[**Experimental**] Figure 1 represents cell configuration and the molecular structure of the materials used in this study. OLED was fabricated on indium-tin-oxide (ITO) coated glass substrate. The chamber pressure was 2.5 x 10^{-4} Pa during deposition of the organic materials and metal. The deposited organic layers consisted of a hole transport layer (HTL) of N, N-diphenyl-N, N-bis(1-naphthyl)-1, 1-biphenyl-4, 4-diamine (α-NPD), a blue emission layer (EML) of methylene-linked compounds of pyrene, i. e., pyrene-$(CH_2)_n$-pyrene, hole blocking layer (HBL) of 2, 9-Dimethyl-4, 7-diphenyl-1, 10-phenanthroline (BCP), and an electron transport layer (ETL) of 3-(4-Biphenylyl)-4-phenyl-5-(4-tert-butylphenyl)-1, 2, 4-triazole (TAZ-01). Then,

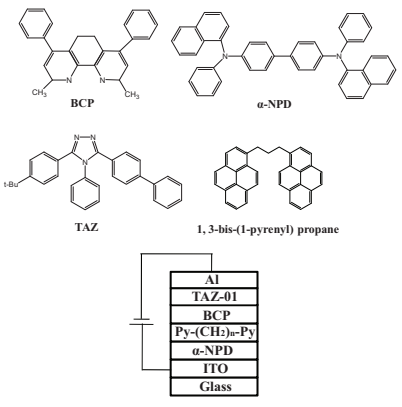

Fig.1: Schematic diagram of EL cell and molecular structures of materials used

finally, a ~ 400 nm thick aluminum layer was deposited. The thickness of all the materials layers were controlled by the co-deposition controller. Current density-voltage-luminance (J-V-L) characteristics were recorded simultaneously with the measurements of the EL spectra by using the spectrometer (Ocean Optics) and a digital multimeter (IWATSU, VOAC7520).

[**Results and Discussion**] Figure 2 (a) and 2(b) show the J-V-L characteristics of Glass/ITO (150 nm)/α-NPD (65 nm)/Py-3-Py (40 nm)/BCP (55 nm)/TAZ-01(40 nm)/Al (400 nm) cell. The current increases above the bias voltage of 8 V, and a large current density of ≥ 1 mA/cm^2 is obtained at 15 V. Light was emitted from the device above the bias voltage of 8 V, and the luminance of the device increased with the bias voltage (Fig. 2(b)). The maximum luminance of ≥ 3000 cd/cm^2 was observed at 15 V. Figure 2 (c) shows the electroluminescence (EL) spectra of the device as depicted in Fig. 1. It is clearly evident that the EL intensity of the device increases with the increase of the applied voltage, because the mobility is increased with the electric field. The device exhibited bright blue EL with an emission peak at approximately 490 nm. We have successfully demonstrated high luminance OLED with the exploitation of the methylene-linked compounds of pyrene. It is revealed that the pyrene-$(CH_2)_3$-pyrene compounds exhibit the bright blue electroluminescence more than 3000 cd/cm^2 as well as from the practical point of view it would be one of the best host materials for OLED and OLEFET devices. The fabrication of the OLEFET by using the Pyrene-$(CH_2)_n$-Pyrene with different value of *n* is under investigation.

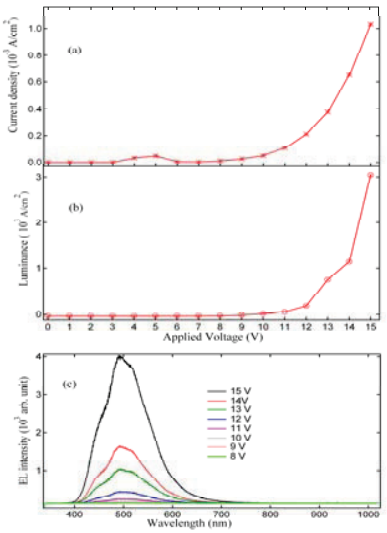

Fig.2: Current-voltage characteristics (a), luminance-voltage characteristics (b), and EL spectrum (c) of Glass/ITO/α-NPD/Pyrene-$(CH_2)_3$-Pyrene/BCP/TAZ/Al

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