Topics

# Organic Light-Emitting Diode Using a Hole-Transporting Emissive Material

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An organic EL (electroluminescent) device has been the subject of much research and development in recent years regarding its characteristics as a self-light emitting device of high intensity with a minor dependence on the angle of visibility, etc. Several companies have introduced products using the organic EL diode. These products in the market at present do not necessarily meet the high temperature durability required for automotive use. One of the causes for this is insufficient heat resistance of the organic materials. To evaluate the heat resistance of the material, the glass transition temperature (Tg) of the material is often quoted as an index. Thus, we carried on the development of the organic EL diode by setting the development of a new material having a high Tg as one of the objectives. This report introduces the characteristics of a high-Tg organic EL diode using hole-transporting emissive material jointly developed jointly with Professor Makoto Kimura of Engineering Studies, Nagoya University[1)].

**Fig. 1** shows the molecular structure of the presently developed material. The dibenzochrysene (DBC) skeleton (hatched portion in the figure) is arranged with 4 amino groups (hereinafter referred to as DBC1). This material has a high Tg (148ºC), and the film using this material has a superb form stability. We have made an organic EL diode with a double layer structure by using the present material for the hole-transporting layers. Tris-(8-hydroxy-quinoline) aluminum ($Alq_3$) was used for the electron transporting layer. This diode has the structure of ITO electrode/DBC1(60nm)/$Alq_3$(60nm)/LiF(0.5nm)/Al(150nm). We have arranged for a diode using diphenylnaphthyl diamine ($\alpha$-NPD) (Tg=95°C) as a representative material for the hole-transporting layer for comparison.

**Table 1** indicates the principal EL characteristics of the respective diodes. The green light emission from $Alq_3$ was observed on the diode using $\alpha$-NPD. On the other hand, the diode using DBC1 was observed to emit a bluish green light having a peak at 495nm coincident with the fluorescence spectrum of the DBC1 film. Emission from the hole-transporting layer can keep the light-emitting region away from the cathodic metal surface, thus suppressing the loss of excitons generated in the light-emitting region on the metal surfaces. Actually, this diode provides a high emission efficiency compared with the diode that emits light from $Alq_3$.

**Fig. 2** shows the measurement result of the emission intensity of the subject diodes after annealing them at each temperature for 30minutes, returning them to room temperature and then

**Table 1** EL characteristics of the EL device using DBC1 in comparison with a conventional device ($\alpha$-NPD/$Alq_3$).

| | Emission peak (nm) | Turn-on voltage (V) | Luminous efficiency (lm/W) | Photometric efficiency (cd/A) | Quantum efficiency (%) |
|---|---|---|---|---|---|
| DBC1/$Alq_3$ | 495 | 2.5 | 3.8 | 6.0 | 2.0 |
| $\alpha$-NPD/$Alq_3$ | 520 | 2.5 | 3.2 | 4.7 | 1.6 |

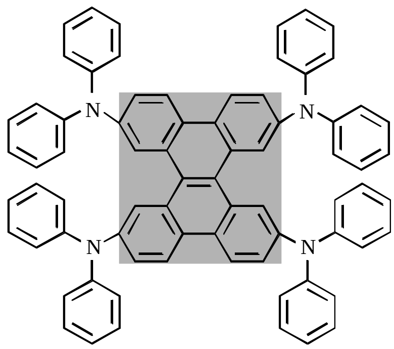


**Fig. 1** Molecular structure of the dibenzochrysene derivative (DBC1).

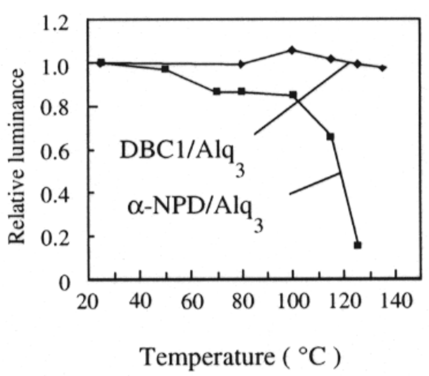


**Fig. 2** The annealing temperature dependence of relative luminance at 11mA/$cm^2$. The samples were annealed for 30 min at each temperature. The luminance was measured at room temperature.

energizing them at 11mA/$cm^2$. The diode using DBC1 shows no degradation in intensity at 130ºC. It is superior in heat resistance to another diode using α-NPD .

As already stated, the newly developed DBC1 is a hole-transporting emissive material of high luminous efficiency. Using this material, we have realized an organic EL diode of high heat resistance. At the present stage, however, the newly developed diode has a short half-value life of luminance, which is about one half that of the diode using α-NPD. Its life is strongly affected by the configuration of the device film thickness and other structures. In the future, development of longer life can be expected through optimization of the device structure.

**Reference**

1) Tokito, S., et al. : Appl. Phys. Lett., **77**-2(2000), 160

(Report received on Feb. 1, 2001