CHEMISTRY LETTERS, pp. 905-906, 1993.

High Luminance in Organic Electroluminescent Devices with Bis(10-hydroxybenzo[h]quinolinato)beryllium as an Emitter

Yuji HAMADA,* Takeshi SANO, Masayuki FUJITA, Takanori FUJII,
Yoshitaka NISHIO, and Kenichi SHIBATA
Functional Materials Reseach Center, Sanyo Electric Co., 1-18-13, Hashiridani, Hirakata, Osaka 573

An organic electroluminescent (EL) devices with bis(10-hydroxybenzo[h]-quinolinate) beryllium ($Bebq_2$) as an emitter was fabricated. A device structure of [ITO / hole transport layer / emitting layer / MgIn] was employed. Its color was green, and its emission peak was 516 nm. This device offered high performance with a luminance of $1.9x10^4$ cd/m^2 and a luminous efficiency of 3.5 lm/W.

Organic EL devices are expected to serve as a new type of flat display.[1)2)] These are injection type devices and have a low drive voltage of less than 10 V. Their performance is influenced by an organic emitting material. To be practical, organic EL devices need organic materials which exhibit both a high luminance and a high luminous efficiency, because device with high performance have good endurance. Conventionally, tris(8-hydroxyquinolinate)aluminum (Alq_3)[1)] has been considered to be the most excellent emitting material for organic EL devices. Although Alq_3 has low fluorescence efficiency, it offers excellent properties as an emitting material, namely, highly stable film formation, high carrier transport capability, and good heat resistance. In this paper, we report that $Bebq_2$ which was newly synthesized as an emitting material exhibits higher performance in EL properties than Alq_3.

$Bebq_2$ was prepared as follows : bq (8 mmol) was dissolved in 40 ml of ethanol-methanol (1:1) in a flask. $BeSO_4$ $4H_2O$ (4 mmol) was dissolved in 100 ml of pure water in another flask. The bq solution was slowly poured into the $BeSO_4$ solution while stirring. $Bebq_2$ was deposited after the mixed solution was adjusted to pH 10 using NaOH. The $Bebq_2$ was filtered and purified by the train sublimation method.[3)] $Bebq_2$ could be easily sublimated because it was inner complex salt. [Element analysis : H 4.12 (4.05), C 78.64 (78.57), N 6.97 (7.05), ( ) calcd]. The chemical structure of $Bebq_2$ is shown in Fig. 1.

The EL devices were fabricated using conventional vacuum vapor deposition in a $1.3x10^{-4}$ Pa vacuum. The device structure was [ITO / hole transport layer (500 Å) / emitting layer ($Bebq_2$, 500 Å) / MgIn (10:1, 2000 Å)]. The emitting area was 2x2 mm^2.

The hole transport layer was composed of N, N'-diphenyl-N, N'-(3-methylphenyl)-1, 1'-biphenyl-4, 4'-diamine (TPD). The luminance of the EL device was measured with a luminance meter and the EL spectrum was measured with a spectrophotometer.

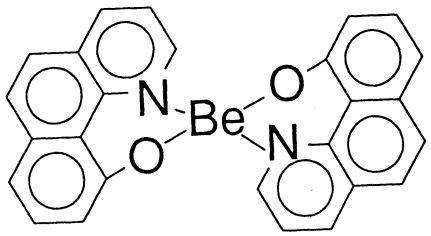

Fig. 1. The molecular structure of $Bebq_2$.

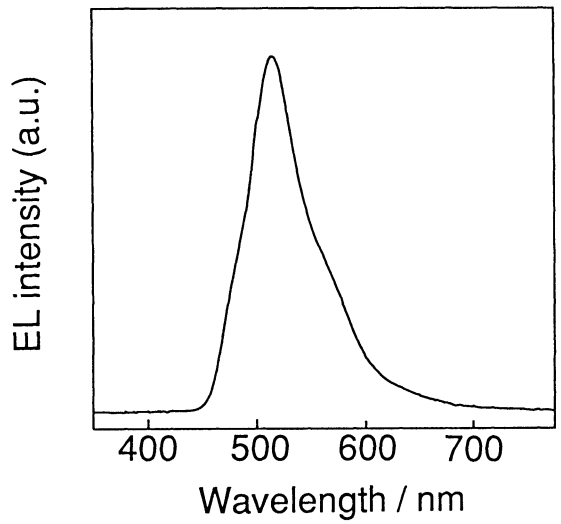

Fig. 2. The EL spectrum of the EL device with $Bebq_2$.

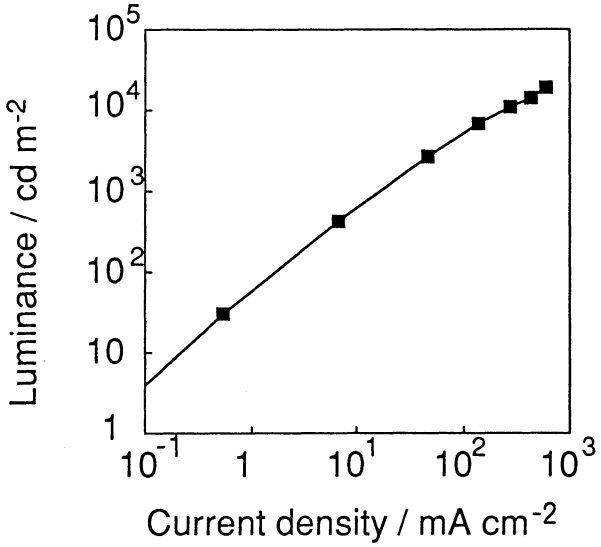

Fig. 3. The luminance-current density characteristics of the EL device with $Bebq_2$.

The photoluminescence (PL) spectra of $Bebq_2$ films (1000 Å) were measured with a fluorescence spectrophotometer. All measurements were carried out at room temperature in air.

The deposited $Bebq_2$ films were amorphous and had a good heat resistance because $Bebq_2$ has a high melting point (368 °C). The quality of the $Bebq_2$ films was uniform and fine, and no crystallization was found on the films after deposition. The fluorescence of the $Bebq_2$ films was green, and their PL peak wavelength was 515 nm. The EL spectrum of the device is shown in Fig. 2. The EL color of the device was green, and its EL peak wavelength was 516 nm. Its spectral half-line-width was 64 nm, which is narrower than that of Alq_3. The EL and PL peaks of $Bebq_2$ were almost identical, indicating that the emissions originated from the emitting layer.

The luminance-current density characteristic of the EL device with $Bebq_2$ is shown in Fig. 3. The luminance was proportional to the injection current in the region of $1\text{-}10^2$ mA/cm^2, indicating that $Bebq_2$ has good electron transport capability in a two-layer device structure. The maximum luminous efficiency of the device was 3.5 lm/W at a luminance of $1.2\text{x}10^2$ cd/m^2. This luminous efficiency is superior to that of Alq_3 (1.5 lm/W).[1] The maximum luminance was $1.9\text{x}10^4$ cd/m^2, which is also superior. The PL intensity of $Bebq_2$ films was 2.6 times stronger than that of Alq_3 in the same film thickness (1000 Å). It seems that the device with $Bebq_2$ exhibits high-performance because $Bebq_2$ has higher fluorescence efficiency.

We expect that $Bebq_2$ will be used for an organic EL device as a new emitting material which has both high luminance and high luminous efficiency.

References

1) C. W. Tang and S. A. VanSlyke, *Appl. Phys. Lett.*, 51, 913 (1987).
2) C. Adachi, S. Tokito, T. Tsutsui, and S. Saito, *Jpn. J. Appl. Phys.*, 27, L269 (1988).
3) J. Wagner, R. O. Loutfy, and C. K. Hsiao, *J. Mater. Sci.*, 17, 2781 (1982).

(Received February 17, 1993)