

A New Series of Electroluminescent Organic Compounds

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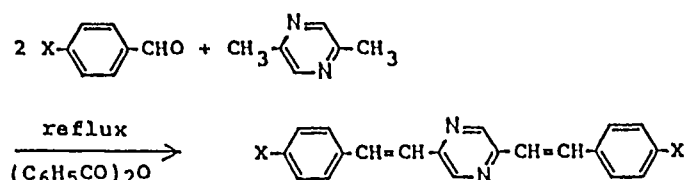
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A new series of electroluminescent organic compounds, 2,5-distyrylpyrazine derivatives, were prepared and investigated on EL properties. The high brightness was achieved in some of these compounds at a low dc voltage of about 10 V.

Little works have been carried out on new electroluminescent organic compounds after the report of 8-hydroxyquinoline aluminum and perylene.^{1a,1b)}

In the course of study on the topochemical photoreaction of 2,5-distyrylpyrazine(DSP) derivatives, we found a new series of promising compounds for EL devices. These compounds were prepared by Aldol condensation of 2,5-dimethylpyrazine with a great excess amount of corresponding aromatic aldehyde(Scheme 1).²⁾ All these new compounds are brilliant yellow - green crystals and photostable in the crystalline state except DSP crystal.



Scheme 1.

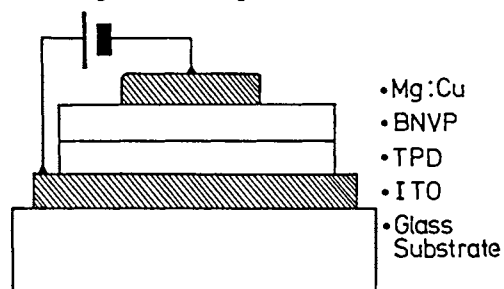


Fig. 1. Structure of EL cell.

Several examples of the materials in present work are shown in Table 1.

The experimental method and the result of EL measurement are explained of 2,5-bis [2-(1-naphthyl)vinyl]pyrazine(BNVP).

Figure 1 shows the structure of the organic EL cell comprised of double layers. The first layer (about 60 nm thick) on an ITO (Indium-tin-oxide) coated glass substrate is an organic hole transporting one composed of N,N'-diphenyl-N,N'-bis(3-methylphenyl)-(1,1'-biphenyl)-4,4'-diamine(TPD). The second layer (about 60 nm) is an organic emitting one composed of BNVP. The electrode on the emitting layer consists of a mixture of magnesium and copper. The EL cell was prepared by vacuum evaporation(2×10^{-4} Pa). The organic layers were successively deposited at the rate of 0.1-0.3 nm/s. The Mg:Cu electrode was

Table 1. EL Properties of the DSP derivatives

Compd.	Mp θ m/ $^{\circ}$ C	EL (λ_{\max} /nm)	Luminance cd m $^{-2}$
X = H a) (DSP)	236	not measurable	
X = CH $_3$	231	473	14
X = C $_2$ H $_5$	211-212	512	270
X = C $_6$ H $_5$	318-320	548	50
X = OCH $_3$	233-235	497	160
BNVP b)	213-214.5	565	932
B2NVP c)	319-320	498	18

a) Photoreactive crystal. b) See the text.

c) 2,5-Bis [2-(2-naphthyl)vinyl]pyrazine.

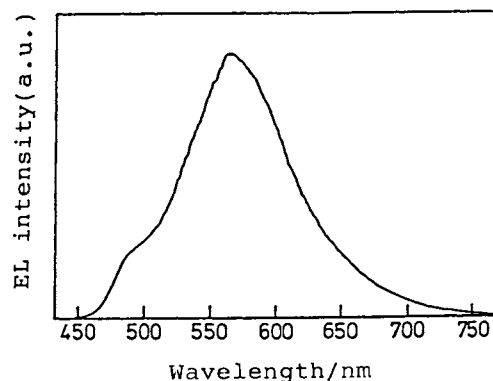


Fig. 2. EL spectrum of ITO/TPD/BNVP/Mg:Cu.

deposited by simultaneous evaporation. $^{1a)}$

Light emission was observed under the forward dc bias with the positive voltage on the ITO electrode. The EL cell emitted visible yellow luminance at the voltage of 10 V, which was bright enough to be observed even in a normal bright room. The luminance was measured by a brightness meter (Minolta LS110), and attained to high brightness level (360 cd/m 2) at the current of 68.7 mA/cm 2 . The luminous efficiency was estimated to be 0.16 lm/W, which was about one tenth of commercially available LED. The luminance and the current increased to 932 cd/m 2 and 213 mA/cm 2 , respectively with increasing applied voltage up to 12 V.

The emission spectrum of the EL cell is shown in Fig. 2. The peak intensity was at 565 nm (λ_{\max}) and the FWHM (full width at half maximum) was about 100 nm.

By the measurement of the current-voltage (I-V) characteristic, the current was found to be proportional to V^2 in the low voltage (current) range below 2 V (10 $^{-9}$ A/cm 2) and proportional to $V^{1.1}$ in the range between 2 and 12 V. This should be attributed to the transition from a single carrier (hole) injection to a double injection at 2 V. $^{3)}$ The current dependence of the luminance was also measured and the luminance was found to be proportional to I in the high current range above 3 mA/cm 2 , as shown by other groups. $^{1a,3)}$ In the low current range between 0.09 and 3 mA/cm 2 , the luminance was proportional to $I^{1.3}$. Some other DSP derivatives were used as an emitting layer and visible green lights were observed at the luminance of a few hundreds cd/m 2 , as shown in Table 1 (X = C $_2$ H $_5$, OCH $_3$).

Further works on some other compounds, the correlation between the structure and EL behavior in a series of DSP crystals are in progress.

References

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