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ORGANIC ELECTROLUMINESCENT PROPERTIES OF TRI- AND TETRASTYRYLPYRAZINE DERIVATIVES

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A new series of electroluminescent organic compounds, 2,3,5-tri- and 2,3,5,6-tetrastyrylpyrazine derivatives, were prepared, and their organic electroluminescent properties were investigated. The high brightness was achieved for some of these compounds at a low dc voltage.

2,5-Distyrylpyrazine (2,5-DSP) is one of the most famous monomers for the four-center type photopolymerization, which proceeds by repeating [2+2] photo-cyclodimerization in the crystalline state.[1] On the other hand, it has been found that thin layers of several photostable 2,5-DSP derivatives showed striking electroluminescent behavior in junction with a hole transport layer.[2] Recently, we extended this study concerning electroluminescent 2,5-DSP derivatives into tri- and tetrastyrylpyrazine derivatives (TriSP and TetraSP).

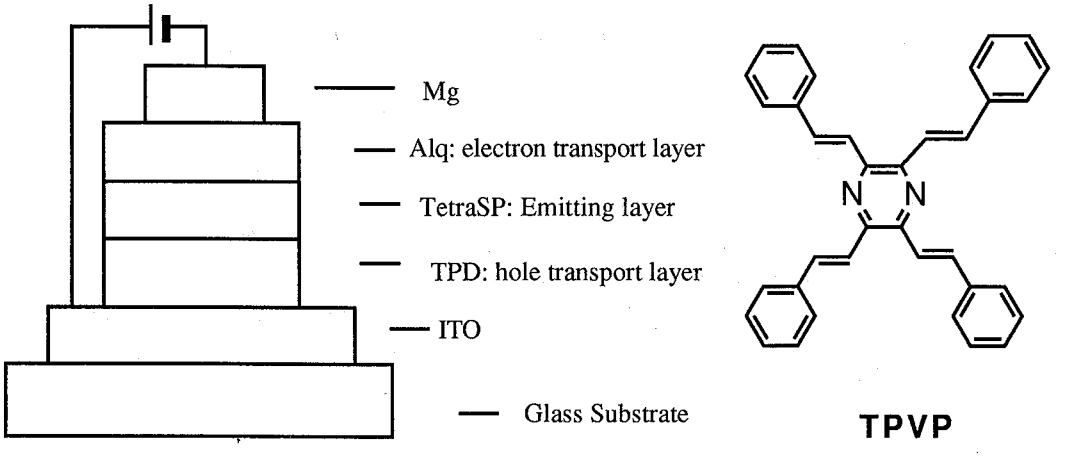

Fig.1. Structure of EL cell and Molecular Structure of a Typical TetraSP

All of these TriSP and TetraSP derivatives were prepared conveniently by the Aldol condensations of 2,3,5-trimethyl- or 2,3,5,6-tetramethylpyrazine with a large excess amount of the corresponding aromatic aldehyde. Two- and three-layer structures of EL cells were used in the present work; the two- layer EL structure was achived as reported by Tang and Vanslyke.[3]

Figure 1 shows the structure of the organic EL cell, comprised of three layers, and the molecular structure of a typical TetraSP. The cell structure was ITO (Indium-tin-oxide)/hole transport layer/emitting layer/Mg. For the hole transport and electron transport materials, N,N'-diphenyl-N,N'-bis(3-methylphenyl)-1,1'-biphenyl-4,4'-diamine (TPD) and 8-hydroxyquinoline alminum (Alq) were used, respectively. The emitting materials were TriSP and TetraSP derivatives.

As a result, we found that a new series of TriSP and TetraSP derivatives showed strong electroluminescence under a forward dc bias. For example, 2,3,5,6-tetrakis[2-(4-methylphenyl)-ethenyl]pyrazine was photostable and showed strong fluorescence and striking EL behavior (4069 cd/m^2 at 151 mA/cm^2). The luminous efficiency was estimated to be 0.7 lm/w at a luminance of 100 cd/m^2. The results for several TriSP and TetraSP derivatives and their family are shown in Table 1.

Table 1. EL Properties of TriSP and TetraSP Derivatives and Their Family

	Compd.	Mp.(°C)	Maximum luminance (cd/m^2)	Photostability
TriSP:	X=H (TPEP)[a]	168	60	yes
	X=CH_3 (TMPEP)[a]	203	10	yes
	X=CF_3 (TTFMEP)[a]	224	40	yes
TetraSP:	X=H (TPVP)	361	3357	yes
	X=CH_3 (TMPVP)	283	4069	yes
	X=Cl (TCPVP)	317	1516	yes
	T3PVP	300	250	yes
	TNVP	312	752	yes

X: The substituent groups of 2,3,5-Tris or 2,3,5,6-Tetrakis[2-(4-substituted phenyl)ethenyl]pyrazine

T3PVP: 2,3,5,6-Tetrakis[2-(3-pyridyl)ethenyl]pyrazine

TNVP: 2,3,5,6-Tetrakis[2-(1-naphthyl)ethenyl]pyrazine

a: Measured in atmosphere

Light emissoin was observed for these compounds under a forward dc bias with a positive voltage on the ITO electrode. We in detail studied organic electroluminescent properties, such as

current versus voltage characteristic, luminance versus current characteristic, EL spectrum, degradation, and substituent effect, upon using TriSP and TetraSP derivatives as emitting materials.

The current versus voltage and luminance versus current curves for the EL cell, in which 2,3,5,6-tetrakis[2-(4-substituted phenyl)ethenyl]pyrazines (4-H: **1a**, 4-CH_3: **1b**, 4-Cl: **1c**) were used as emitting materials, are shown in figures 2 and 3, respecively. The current was proportional to V^{11} in a low voltage range below 10 V and proportional to V^9 in a range higher than 20 V. Moreover, the luminance was found to be proportional to the current. These results indicate that a singlet exciton is directly genarated by an electron-hole recombination. The EL efficiency were **1b >1a >1c.**

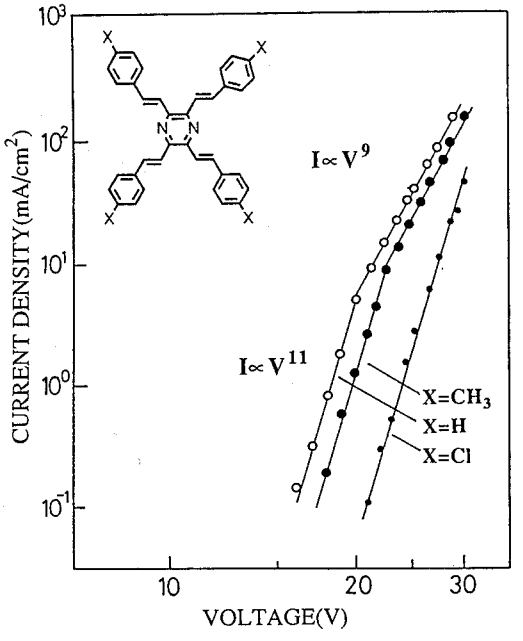

Figure 2. Current-Voltage Characteristic of TetraSP Derivatives

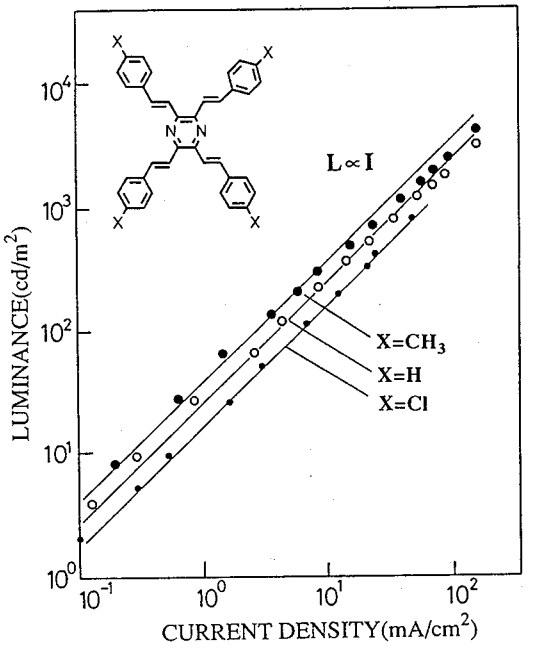

Figure 3. Luminance-Current Characteristic of TetraSP Derivatives

All of these TriSP and TetraSP derivatives were photostable and showed high bright level of electroluminescence, and were found to be useful as novel emitting materials for electroluminescent devices.

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