CHAPTER - III

SPECTRAL ENERGY DISTRIBUTION OF EL. EMISSION AND MECHANISM OF ELECTROIUMINESCENCE

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3.1: SPECTRAL ENERGY DISTRIBUTION OF EL. EMISSION AND MECHANISM OF EL.

3.1: A) PURE ANTHRACENE, PYRENE AND PERYLENE :

The spectral energy distribution (S.E.D.) of El. emission of the pure anthracene and pure pyrene at slected voltages and frequencies is given in the Table No.1 and 2 and graphically presented in Fig.No. 4 and 5. It is observed from the Fig.No.4 and 5 that there is no noticeabale change in visible colour and S.E.distribution of El. emission of anthracene and pyrene. Within the experimental limits, the electroluminescence spectra of anthracene and pyrene are found to be identical with their normal fluorescence spectra. Examination of S.E.D. curves revel that in every case no addition bands to the normal fluorescence spectrum of the compounds are observed in the spectral region studied. From the figures it is evident that the blue spectrum of emitted light output of pure anthracene and the bluish green spectrum of the emitted light output of pure pyrene show an intense sharp band at 4750 A° and intense broad band at 5100 A° respectively. In addition to above observations, no spectral shift was observed with change in voltages and frequencies of the excitation field as it is observed in many inorganic systems. Thus X max are unaffected.

Electroluminescence in anthracene has been studied by

48

(P. 2. " Page 53)

Table No. 1: Spectral energy distribution of El.emission of pure anthracene at different excitation voltages and frequencies.

W avelength			E1.1 nt	ensity 'B'	(A •U•)			
of El. emission	5	00 Y		4	100L		006	¥
٩٥	1000 Hz	1500 Hz	2000 Hz	1000 Hz	1500 Hz	2000 Hz	1500 Hz	2000 Hz
4200	0•02	0.12	0.18	0.05	0.44	0•30	0.75	1•0
4400	0.10	0.22	0.43	0•28	0.73	0*80	1.10	1-37
4600	0.19	0.33	0 . 68	0*50	1.00	1.13	1.20	1.90
4750	0•23	0.41	0.84	0.65	1.07	1.25	1.42	1.88
4900	0.19	0.37	0•76	0.62	1.04	1.18	1 . 29	1.79
5000	0.13	0.33	4 7 • 0	0•56	0.95	1.13	1.25	1.7.1
5200	0.05	0.23	0•60	0.42	0.85	1.00	1.18	1.56
5400	1	0.12	0.45	0.24	0•69	0.91	1.10	1.37



Fig. 4 — SPECTRAL ENERGY DISTRIBUTION OF EL EMISSION FOR PURE ANTHRACENE AT VARIOUS EXCITATION VOLTAGES AND FREQUENCIES.

Spectral energy distribution of El.emission of pure pyrene at different applied voltages and frequencies. Table No.28

2000 Hz 5.70 8.00 8.90 8.70 8.25 6.50 5.08 3.25 7.10 8**.**65 7.60 6.00 6.00 A 006 1500 Hz 6.00 6.70 7.10 6.00 2.50 5.25 7.20 6.60 4.50 1.20 5.25 3.50 •25 2000 Hz 2**.**0 6.00 5.00 5.60 5.95 5.50 1.20 0.60 4.25 4.75 4.00 3.25 2.50 1500 Hz 'B'(A.U.) 8.1 2.50 3.50 4.50 5.00 **4**•80 4.75 4.30 2.40 3.45 0.75 0.35 700 V 1 1000 Hz El.intensity 1.00 1.25 0.50 0.20 1.25 1.30 0.85 0.65 0.25 8.0 ŧ 8 ł 2000 Hz 0.70 2.20 0.20 1.50 2.90 3.40 3.10 2.40 8.0 3.25 1.50 8. 1 1500 Hz 1.70 0.35 0.00 1.25 8.8 1.90 1.75 1.50 1.30 0.80 0.30 0.15 ŧ 500 V 1000 Hz 0+•0 0.50 0.50 0.26 0.75 0.70 0.20 0.05 1 ł 1 1 Ì Wavelength enission A^o 4900 5100 5200 4400 **1**600 4800 5000 5400 5600 5800 6000 6200 6400 of Bl.



Fig. 5 — SPECTRAL ENERGY DISTRIBUTION OF EL-EMISSION FOR PURE PYRENE AT VARIOUS EXCITATION VOLTAGES AND FREQUENCIES.

several workers^{54,68-b, 93-95}. These investigations involve electroluminescence of intrinsic as well as extrinsic type. Anthracene is a conjugated aromatic hydrocarbon and has been reported to be a highly fluorescent compound. Inside the anthracene crystal the molecules are packed in a repeating pattern of unit cells, each of which contains two complete molecules. The unit cell is monoclinic, that is, two of its axes (a and b) are at right angles to each other but the third axi^os (c) is at an angle other than a right angle to the other two.

The correct interpretation of the El. of anthracene was given by Helfrich and Schneider⁵⁴ and Mehl and Büchner⁹³, who attributed the luminescence to the radiative recombination of electrons and holes injected into the crystal from suitable contacts. This process involves introduction of an electron into the conduction band of the material and introduction of a hole into the valene band. These holes and electrons diffuse through the molecule on application of electric field until they combine and result in El. emission.

From survey of literature, it seems that no work has been done on electroluminescent properties of pyrene and therefore, we believe this is the first report on electroluminescence in pyrene.

Pyrene has been reported to be highly fluorescent compound. The electroluminescence in pyrene may take place via either of

the two following mechanisms.

1) Pyrene is an insulator, therefore the valene band and conduction band are widely spaced. When pyrene is excited by a.c. fisdd the electrons from the valene band evaporate into the conduction band, thus leaving holes in valence band. The electrons are generally excited to first singlet excited state. After the initial application of several cycles of the field the population of electrons in conduction band is in excess over those populated thermally. The electrons in excited level subsequently combine radiatively with the holes created in valence band, resulting in El. emission.

2) Our EL. emission spectrum of crystalline pyrene consists of broad emission band at 5100 Å⁰, which seems to be identical with the broad fluorescence emission band observed by stevens⁹⁶ for crystalline pyrene and broad structureless fluorescence observed by Förster and Kasper⁹⁷ for pyrene in solution. Förster and Kasper interpreted the results by postulating that the species responsible for the broad, structurelCess fluorescence was excited dimer, formed by combination of an electronically excited pyrene molecule with a pyrene molecule in the ground state. Stewens and Hutton⁹⁸ have proposed the name "excimer" for an excited dimer of this type, in order to distinguish this species from an excited state of a dimer which is stable in

its ground state. The formation of excimer in solution is thought to be a diffusion controlled collision process, in which a surprisingly large fraction of the collisions between excited and unexcited monomers are effective. The excimer so formed dissociates after emission of radition. The phenomenon of excimer formation has also been observed in organic crystals 97,99,100. Our experimental result indicates that the mechanism of El. emission of pyrene should be identical with the mechanism proposed by Forster and Kasper and Stevens for fluorescence spectra of pyrene in solution and for crystalline pyrene respectively. The lattice structure of pyrene molecule is such that the lettice unit is a pair of overlapping parellel molecules, i.e. TI -orbital overlap of adjacent parellel molecule is large, so that this Crystal should favour excimer formation, and show the excimer type luminescence. Thus, when microcrystalline pyrene powder sandwitched between two plane parellel electrodes is excited by a.c. field, some of the molecules are electronically excited. These electronically excited molecules combine with unexcited molecules and form the excimers. The excimer so formed dissociates after Sl. emission. This process may be represented step wise as follows :

 $\frac{\text{Step}}{1) \quad A(s_0) \xrightarrow{a.c.field} A_{cs_1}^*} \xrightarrow{\text{Description}} \\ 1) \quad A(s_0) \xrightarrow{a.c.field} A_{cs_1}^* \qquad \text{Electronic excitation} \\ 2) \quad A_{cs_1}^* \rightarrow A(s_0) \rightarrow (AA)^* \qquad \text{Excimer formation} \\ 3) \quad (AA)^* \longrightarrow 2A(s_0)^* hv \qquad \text{El. emission} \\ \end{array}$

Table No. 3: Spectral energy distribution of El. emission of pure perylene at different excitation voltages and frequencies.

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Wavelength			El.intens	ity 'B' (A.	.U.)			
of El. emission		500 V			700 V		006	A
Ao	1000 HS	1500 Hz	2000 Hz	1000 Hz	1500 Hz	2000 Hz	1500 Hz	2000 Hz
4400	0.01	0•03	0.05	10*0	0•10	0.12	0.13	0.15
4800	0.03	0.05	0.10	0*08	0.13	0.17	0.19	0,28
5000	0.04	0.07	0.13	0.10	0.17	0.23	0.30	0.37
5200	0.05	60*0	0.17	0.13	0.20	0•30	0.38	0.49
5400	0.07	0.10	0.18	0.15	0.22	0.37	0.43	0.53
5600	0.06	60*0	0.17	0.14	0.20	0.33	0.39	0*50
5 800	0.05	0.08	0.15	0.12	0.17	0.27	0.33	0.43
6000	0.04	10.0	0.13	0.11	0.15	0.20	0.23	0.33
6400	0.04	0 •0 6	0•08	0.11	0.12	0.15	0.17	0.22



Fig. 6 — SPECTRAL ENERGY DISTRIBUTION OF EL. EMISSION FOR PURE PERYLENE AT DIFFERENT EXCITATION VOLTAGES AND FREQUENCIES -

The spectral energy distribution (S.E.D.) of El.emission of pure perylene is given in the Table No.3 and graphically represented in Fig. No. 6. It is observed from the figure that there is no noticeable change in visible colour and S.E.distribution of El. emission and the emitted light output of pure perylene shows an intense yellow broad band at 5400 A° . Within the experimental limits, the electroluminescence spectra of perylene is found to be identical with its normal broad, structureless fluorescence spectra as reported by Hochstrasser¹⁰⁰.

The crystalline perylene exhibit lattice structure similar to the lattice structure of pyrene, in which the lattice unit is a pair of overlapping parellel molecules, i.e. **T**-orbital overlap of adjacent parrellel molecule is large, so that these crystal should favour excimer formation and show eximer type luminescence. Therefore, electroluminescence mechanism of pure perylene is quite similar to that of El. mechanism of pyrene as explained above.

3:1 - 3) Electroluminescence of two phase organic systems:

Considering the very great body of work which has been devoted to the study of the effects of impurities on the electronic properties of inorganic semiconductors, investigation on the role of impurities in organic compounds have been quite limited. Hence only a few papers have been published do date dealing with the electroluminescence phenomenon of organic compounds doped with impurities.

i) Electroluminescence in the anthracene-pyrene system:

Recently some work has been done on doped anthracene. From survey of literature, it seems that no work has been done on electroluminescence in anthracene-pyrene system, and therefore, we believe this is the first report on electroluminsence in anthracene-pyrene system (Table No.5). The spectral energy distribution (S.E.D.) of anthracene-pyrene system for different dopant concentration of pyrene at 700 V and 1500 Hz frequency is given in Table No.4 and graphically presented in Fig.No.7. It is observed from the figure that for pure anthracene maximum emission is obtained at 4750 A° , whereas for pyrene at 5100 A° . The electroluminecence spectra of the anthracene doped with various concentration of pyrene measured at room temperature, consists of characteristics broad, structureless bands peaking at 5100 A^{O} of pyrene only, whereas characteristic blue bands of anthracene are not observed at 4750 A^O. This clearly indicates that the El. emission in anthracene pyrene system should be principally due to pyrene only. Similarly it was also observed that intensity of El. emission increases with decreasing concentration of pyrene and El. spectrum was not modified by increase in concentration.

The spectral energy distribution (S.E.D.) at selected voltages and frequencies has been given in Table Nos. 6-8 and

py.per mole anthracene Bole 0.56 0.45 0.65 0.60 0.20 0.55 0.25 powder containing pyrene (py) as contaminant at excitation voltage of 700 V 0.20 0.25 0.35 0.27 0.31 Spectral energy distribution of El.emission of microcrystalline anthracene 10-2 1 per mole anth- 1 5x10⁻² mole 0.30 0.10 0.30 0.45 0.35 0.27 0.17 0.15 0.20 0.25 0.37 0.21 racene I mole py.per 10⁻¹ mole py.per mole anthracene 'B' (A.U.) 0.19 0.30 0.15 0.16 0.20 0.35 0.32 0.27 0.25 0.25 0.06 0.12 2 El. intensity Pure Pyrene 0.10 0.10 0.13 0.05 0.15 0.13 0.03 0.01 0.01 0.04 and 1500 Hzs frequency. 1 I ł Pure Inthracene 0.26 0.30 0.29 0.29 0.28 0.27 0.26 0.23 0.22 0.18 0.16 0.25 0.19 Table No.44 Wavelength emission A^o 5100 5200 5300 5600 of El. 4600 4750 4800 4900 5000 5400 5800 **1100** 1200

Sr.No.	Mole of pyrene added per mole of anthracene	Visible colour of El.emission	Anax Ao	El.intensity (arb.units) at) max (700 V,1500 Hzs)
Ч	Pure anthracene	Blue (m)	4750	0.30
2	10-2	- Green (s)	5100	0•65
m	s x 10 ⁻²	Green (m)	5100	0.45
+	10-1	Green (w)	5 100	0.35
5	Pure Pyrene	Bluish green(m)	5 100	0.15

Table No. 5 : Effect of addition pure pyrene on El. emission of blue emitting anthracene



Fig. 7 - SPECTRAL ENERGY DISTRIBUTION OF EL. EMISSION OF MICROCRYSTALINE ANTHRACENE POWDER CONTAINING PYRENE AS CONTAMINANT AT 700 V & 1500 Hz FREQUENCY.

graphically presented in Fig. Nos. 8-10, for the dopant concentrations, 10^{-2} , 5 x 10^{-2} and 10^{-1} mole of pyrene per mole of anthracene respectively. It was found that the S.E.D. is independent of voltage and frequency of excitation, over the entire range studied and max remains constant at 5100 A°. It is seen that for all the phosphors, no noticeable colour shift is observed when voltage is varied. Same has been found to be true for frequency dependence of EL. emission, studied at different constant voltages.

So we think that the mechanism of process involved in light emission in this system must be due to energy transfer from anthracene to pyrene. An efficient energy transfer from host (anthracene) to dopant (pyrene) may take place via either of the following mechanisms. Most probably, electrons recombine with holes trapped at pyrene traps producing pyrene excitons, which may subsequently decay to ground state by the guest fluorescene. Alternatively, anthracene excitons may be produced first and the energy transfer may produced by a random walk of excitons, as it takes place in photoluminescence of doped anthrencene crystals.

The comparison of the electroluminescence of pyrene doped anthracene with that observed for tetracene and pentamene doped anthracene suggests that the energy transfer to the guest

63

(P.T. O. page 70)

Vavelength			E.II	ntensity	'B'(A.U.)			
of El. Puission	5	A 00			A 00L		006	Δ.
٩٥	1000 Hz	1500 Hz	2000 Hz	1000 Hz	1500 Hz	2000 Hz	1500 Hz	2000 Hz
4400	1.00	3.30	3.50	2.90	4 .00	4.80	5.80	7.00
4600	1.50	3.60	4 .00	3 •20	5.00	5.80	7.40	9•30
4800	2.15	4.20	5.00	3.40	6.60	7.60	10.00	13.20
5000	2.75	5.10	7.50	4.00	8.00	11.70	14.60	16.40
5100	3.00	6.75	10.00	6.00	10.00	14.80	15.75	16.70
5200	2.95	6.30	8 •8 5	5 •50	11.60	14.20	15.60	16.20
5400	2.50	5.00	6.50	4 .00	11.00	08 °6	13.20	15.00
5600	2.00	4.20	5 •50	3.50	8 . 00	7.20	9. 80	12.90
5800	2.50	3•75	4.50	3.00	6.15	5.80	7.50	10.40
6000	2.00	3 • 20	4.10	2.60	5.25	5.00	6.00	8,00
6200	0•50	3.00	3.65	2.30	4.70	4.40	4.85	6.30

Table No.6: Spectral energy distribution of El.emission of anthracene doped by pyrene (10-2 mole pyrene per mole of anthracene)at different voltagesand frequencies.



Fig. 8 - SPECTRAL ENERGY DISTRIBUTION OF EL-EMISSION OF ANTHRACENE DOPED BY PYRENE [10⁻² mole/mole of Anthracene] AT DIFFERENT EXCITATION VOLTAGES AND FREQUENCIES -

Table No.7 : Spectral energy distribution of El.emission of anthracene doped by pyrene (5×10^{-2} mole of pyrene per mole of anthracene) at different excitation voltages and frequencies.

Wavelength			El.int	ensity 'B'	(•n•)			
enission		500 V			700 V	f 1	006	Α
•∎0	1000 Hz	1500 Hz	2000 Hz	1000 Hz	1500 Hz	2000 Hz	1500 Hz	2000 Hz
4400	0*30	1.40	2•00	0•80	3 . 20	2 .80	4.00	6.00
4600	0•50	2.30	2.95	1•25	4.10	5 . 00	6.60	8•80
4800	1.00	3 • 30	4.20	1.80	5.50	7.65	9•60	12 .00
5000	1.50	4.85	5.70	3•00	8 . 00	11.00	13.15	14.00
5100	1.70	5.75	8.40	4 •00	10.75	12 •50	13.75	14.40
5200	1.60	5.40	7.80	3.75	10.30	12.00	13.50	14 . 10
5400	1.20	4.60	6.00	2.50	7.80	10.50	12,00	13.00
5600	0.80	3.15	4.20	1.20	6 • 00	8•30	10.10	11,20
5800	0*50	2.20	3.20	1.10	4.60	6 • 00	8.45	06*6
6000	0.30	1.70	2.70	0*95	3.30	4 •00	6 • 00	8.00
6200	020	1.20	2 • 45	0 •10	2.00	3.00	4.10	5 •80



Fig. 9 - SPECTRAL ENERGY DISTRIBUTION OF EL EMISSION OF ANTHRACENE DOPED BY PYRENE [5x10² mole/mole Anthracene] AT DIFFERENT EXCITATION VOLTAGES AND FREQUENCIES

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Table No. & : Spectral energy distribution of El.emission of anthrancene doped by pyrene (10⁻¹ mole pyrene per mole of anthracene)at different voltages and frequencies.

Wavelength			L E	.intensity	'B'(A.U.)			
or El. Emission		500 V			700 V		006	۰۰۰۰۰ ۸ (
Ao	1000 Hz	1500 Hz	2000 Hz	1000 Hz	1500 Hz	2000 Hz	1500 Hz	2000 Hz
4400	1.00	3 • 30	3 .60	2 •95	4•00	4.80	5.75	7.00
4600	1.50	3.60	4 .00	3 • 20	5.00	5.85	7.40	9•30
4800	2.15	4.20	5.00	3.45	6.60	7.60	10.00	13.20
5 000	2.75	5.15	7.50	4.00	8.00	11.80	14.75	16.40
5100	3.10	6 . 85	10.00	5.90	10.00	14.80	15.80	16.80
5200	3.00	6.25	8•75	5.50	11.55	14.20	15.70	16.30
5400	2.50	5.00	6.50	4.00	11.00	9•70	13.20	15.00
5600	2.00	4.20	5 •50	3 • 50	8.00	7.20	9.80	13.00
5800	1.50	3.70	4.75	3.00	6.20	5.80	7.50 .	10.40
6000	1.00	3.20	4.10	2.60	5+35	5.00	6.00	8,00
62 00	0.50	3,00	3.60	2.30	4.50	4.40	4.80	6.40



Fig. 10 - SPECTRAL ENERGY DISTRIBUTION OF EL EMISSION OF ANTHRACENE DOPED BY PYRENE (10¹ mole/mole of Anthracene) AT DIFFERENT EXCITATION VOLTAGES AND FREQUENCIES

molecules may primarily occur by recombination at dopant traps producing singlet excitions of dopant. The alternative explanation, i.e. that of energy transfer taking place by random walk of host excitons is essentially identical with the process described to account for photoluminescence behaviour of doped anthracene.

Alternatively, we would like to suggest that the excited pyrene molecule which may be formed by above energy transfer mechanisms, combines with its unexcited ground state molecule and forms the excimer. The excimer so formed dissociates after El. emission.

The energy transfer mechanisms, mentioned as above seems to be inefficient than the energy transfer involved in tetracene and perylene doped anthracene systems. This is mainly because, the efficiency of the singlet-signlet and the triplet-triplet energy transfer processes depend on the relative energies of the states involved in the transfer step. If the energy of excited state of the host is greater than that of the excited state of the guest, the transfer is relatively efficient but when reverse is the case the transfer is inefficient. In case of pyrene doped anthracene system, the pyrene singlet and triplet are higher in energy than the corresponding anthracene levels. The energy

difference in triplet levels of pyrene and anthracene (0.21Mm^{-1}) is greater than the energy difference in singlet levels (0.05Mm^{-1}) of corresponding compounds ¹⁰¹. Hence, if above mechanism of energy transfer is applicable to pyrene-anthracene system, it should be only due to singlet-singlet energy transfer, though it will be inefficient.

At this stage, we would like to say that the results reported by us in the present work do not allow us to give the correct mechanism. Therefore, the fresh experimentation is necessary to clarify this point.

ii) Electroluminescence in Pyrene-perylene system :

Recently some work has been done on the fluorescence emission of pyrene doped with perylene. But the literature survey shows that no attention has been made to study El.properties of pyrene-perylene system.

The spectral energy distribution of pyrene-perylene system for different dopant concentration of perylene at 700 V and 1500 Hzs frequency is given in Table No.9 and graphically presented in Fig. No.11. It is observed from the figure that for pure pyrene maximum emission is obtained at 5100 A° and for perylene at 5400 A° , whereas the electroluminescence spectra obtained for different dopant concentrations show two bands. One smaller, broad, structureless band peaking at about 5000 A° .

	powde 700 V	r containing peryle 1 and 1500 Hzs frequ	ene as contaminant a uency.	at excitation volta	ge of
Wavelength		El.in	tensity 'B'(A.U.)		
of Bl.emi- ssion A ⁰	Pure pyrene	Pure perylene	10 ⁻¹ mole of perylene per mole of pyrene	5x10 ⁻² mole of perylene per mole of pyrene	10 ⁻² mole of perylene per mole of pyrem
4600	0,02	0*05	0.02	0•03	0.04
4800	0.05	0•08	0.03	0°0	0.06
5000	0.13	0.12	0.05	0.07	0•08
5100	0.16	0.13	0.05	0.06	0007
5200	0.13	0.17	0.05	0.06	0*07
5400	0.03	0.20	0.06	0.08	0.10
5 600	0,02	0.19	0.10	0.13	0.15
5800	0.01	0.16	0.13	0.17	0.20
6000	8	0.12	0.17	0.22	0.25
6400	ł	0.07	0.24	0•30	0.35
6800	I	0.01	0.28	0.35	0.41
7000	I	1	0•25	0.31	0+37

Sr.No.	Mole of perylene added per mole of pyrene	Visible colour of El.emission	Amax Ao	El.intensity(arb.units) at Amax(700 V,1500 Hzs)
7	Pure Pyrene	Bluish green (m)	5 100	0•16
0	10 ⁻²	Green (s)	5000	60°0
r	5 x 10 ⁻²	Green (m)	5000 5000 6800	0.07
*	10 ⁻¹	Yellowish green(m)	5000 6800	0.05 0.28
n	Pure Perylene	Yellow (s)	5 400	0.20

Table No. 15 : Effect of addition of perylene on El. emission of pure pyrene powder at



Fig. 11 — SPECTRAL ENERGY DISTRIBUTION OF EL. EMISSION OF MICROCRYSTALINE PYRENE POWDER CONTAINING PERYLENE AS CONTAMINANT AT 700 V & 1500 Hzs FREQUENCY.

78

The figure also indicates that the intensity of El.emission increases with decrease in concentration of perylene and El. spectra was not modified by changes in concentration.

The spectral energy distribution (S.E.D.) at selected voltages : , and frequencies has been given in Table Nos 11-13 , and graphically presented in Fig. Nos. 12-14 , for dopant concentration of 10^{-2} , 5 x 10^{-2} and 10^{-1} mole of peryleme per mole of pyrene respectively. It was found that the S.E.D.is n idependent of voltage and frequency of excitation, over the entire range studied and) maxs remain constant. It is seen from the figures that the light intensity increases rapidly with increase in voltage and frequency. The results on spectral energy distribution of radiation studied at different applied voltages and frequencies give many interesting features in relation to redistribution of intensity in the two bands present in these phosphors. Changes in voltages cause a redistribution of the intensity in these bands. At low voltages and frequencies, weak bluish green emission is observed at 5000 A° , whereas, at high voltages the observed emission is day light with a maximum at 6800 A°. (Table No.10).

As described earlier, the crystal structure of pyrene and perylene are identical, in which the mole cules are arranged in coplanar pairs of which there are two per unit cell i.e. Torbital over lap of adjacent parellel molecule is large, so that these crystals favour; s excimer formation. The electroluminescence spectrum of pyrene and perylene reproduces essentially all the features of their normal fluorescence emission(Fig.11) which was attributable to the formation of excimers.

75

(P.T.O. page 82)

Table No.jj : Spectral energy distribution of pyrene doped by perylene (10⁻² mole of perylene per mole of pyrene) at different excitation voltages and frequencies.

4.6 3.3 6.2 7.1 8.3 5.4 3.9 7.2 8.5 9.5 4.0 3.0 6.7 7.8 9.5
5•4 3•9 7•2 8•5 9•5

76

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Fig.12 — SPECTRAL ENERGY DISTRIBUTION OF EL-EMISSION OF PYRENE DOPED BY PERYLENE [10² mole per mole of pyrene] AT DIFFERENT EXCITATION VOLTAGES AND FREQUENCIES.

- 77

	ទព ថ	frequencies	• 70					
Wavelength			E.L.	Intensity 'B	*(A.U.)			
of El. emission		500 V			700 V		906	Α
₽ 0	1000 Hz	1500 Hz	2000 Hz	1000 Hz	1500 Hz	2000 Hz	1500 Hz	2000 Hz
4400	0.3	0.5	1.2	0,8	1.4	1.8	2.5	2.2
4600	0.5	0.7	1.5	1.0	3.8	2•3	2•9	2 • 8
4800	0 • 6	1.0	1.7	1.4	2•2	2•7	3 . 2	3.5
5000	0.7	1.3	2.1	1.7	2 •5	3.0	3.5	4•0
5200	0.8	1.2	1.9	1.4	2.4	2 . 8	3.4	3 . 9
5400	0.8	1.2	2•0	1.6	2.4	2.8	3.6	4.2
5 600	6.0	1.5	2 • 3	1.8	2.6	3•2	4.0	5.0
6000	1.5	2•0	3.2	2•5	3•8	4.7	5.7	6.7
6400	1.9	2.5	4.1	3 •5	5.2	6.5	7.4	8 . 5
6800	2 . 3	3.1	5•2	4 • 3	6•5	7.5	8 • 8	10.0
2000	1.8	2.9	4.7	3 • 8	5.7	6.3 、	8•2	9 • 2

Table No. 12. : Spectral energy distribution of El. emission of pyrene doped by perylene



Fig. 13 - SPECTRAL ENERGY DISTRIBUTION OF EL. EMISSION OF PYRENE DOPED BY PERYLENE [5×10⁻² mole perylene per mole -Pyrene] AT DIFFERENT EXCITATION VOLTAGES & FREQUENCIES -

W avelength			El.int	ensity 'B'	(.u.)			
of El. emission		500 V			700 V		006	٨
Ao	1000 Hz	1500 Hz	2000 Hz	1000 Hz	1500 Hz	2000 Hz	1500 Hz	2000 HE
4400	0.1	0.5	1.1	0.8	1.5	2.1	2.5	2.9
4600	0•3	0.7	1.5	1.0	2•0	2.4	2.8	3•3
4800	0•3	0.8	1.7	1.3	2.1	2.6	3.2	3.7
5000	0.5	6*0	1.9	1.4	2•5	3.0	3.5	4•0
5200	0.4	0.8	1.7	1.3	2.1	2.7	3.2	3 . 8
5400	0.4	0.8	1.5	1.1	2.0	2.6	3•2	3 • 6
5600	0.6	6*0	1.4	1.2	2•0	2.5	3.5	3.9
6000	0+8	1.1	2•5	1.9	3.4	4.0	5.0	5 •8
6400	1.0	1.6	3•3	2.8	4.4	5.0	6 . 8	7.9
6800	1.5	2.4	4.5	3 . 8	6.0	7.2	8.4	9 • 6
7000	1.0	1.7	4•0	3.4	5.0	6.5	7•7	0•6

Table No.13: Spectral energy distribution of pyrane doped by perylene (10⁻¹ mole of perylene



Fig. 14 - SPECTRAL ENERGY DISTRIBUTION OF EL- EMISSION OF PYRENE DOPED BY PERYLENE [10¹ mole of perylene Permole pyrene] AT DIFFERENT EXCITATION VOLTAGES AND FREQUENCIES.

Perylene was found to dissolve in pyrene to give yellowish crystals. The El.spectra of perylene doped pyrene at different dopant concentration is shown in Fig.11. From the figure it is evident that the spectra consists of two bands, one very weak peaking at 5000 A° and other main broad structureless band situated at 6800 A° . The characteristic El.emission of perylene are completely absent in the spectra.

When pyrene powder containing perylane as contaminant is excited by sinusoidal voltages, the pyrene absorbs energy of excitation. The most of energy absorbed by the pyrene molecule would be trapped by perylene molecule. This transfer of energy may no take place via either of following mechanism. Primarily, by radiative transfer process or alternatively by a resonance phenomenon between allowed electric dipole transitions in donar and acceptor. The emission of free perylene is absent. therefore. the excited species so formed by above mechanism must interact with adjacent pyrene molecules and forms mixed excimers. In the process of interaction, the lowest state of perylene, mixes strongly with the level of pyrene. Association of two molecules results in a further splitting between these levels. The observed emission is therefore, seems to originate from emitting level of mixed excimer, which may be lying well below the emitting level of pyrene/perylene.from which mixed dimer dissociate to give EL.emission at 6800 $\texttt{A}^{\texttt{O}}$ as observed by us experimently.

The appearance of weak band at 5000 A° which seems to be identical with the characteristic emission of pyrene may be arising due to the fact that a very small fraction of excited pyrene may be combining with its ground state molecule forming excimer which dissociate after characteristic El.emission.

The mechanism explained above involves the formation of molecular aggregates in the excited state. The apparent formation of 'mixed excimer' suggests that a high concentration of one compound can cause quenching of intensity of El. emission of another compound. This explains why the intensity of El.emission decreases with increasing concentration of perylene in pyrene.