

CHAPTER - V

SUMMERY

SUMMARY

Since Destriau first announced the discovery of electroluminescence, a multitude of papers has appeared on the subject and progress has been made toward elucidating the mechanism of light production. The phosphor used had been solely inorganic until the work of Barnanose and coworkers, who developed the technique of organic electroluminescence. The first report of El. in organic crystal is probably attributable to Pope et. al. who performed measurements on single crystals of anthracene and anthracene doped with tetracene.

From the survey of literature, it seems that no systematic efforts have been made to investigate the electroluminescent properties of pure organic compounds and two phase organic system. It is the general object of present investigation to study the El. properties of pure organic compounds such as pyrene, anthracene, perylene and two phase organic system like anthracene doped with pyrene and pyrene doped with perylene. The investigation of organic El. often proves to be quite exciting since it combines a number of research areas such as electronics, spectroscopy, electrochemistry, photochemistry, both in solid state and in solution state.

Purification of organic compounds and preparation of phosphors:

Solid organic compounds isolated from organic reaction were seldom pure. They were usually contaminated with small amounts of other compounds i.e. impurities. Even a trace of impurity in the compound markedly changes its electrooptical properties and therefore, the purification of the organic compounds often must be performed prior to electroluminescence study. The commercial grade anthracene and pyrene were purified separately by the process of adsorption column chromatography.

The organic phosphors were prepared by dissolving the calculated amounts of dopants (doping agent) and host in hot A.R. grade benzene and evaporating the solution to dryness. The mixture of crystals obtained was crushed into a powder form. Thus phosphors containing 10^{-2} , 5×10^{-2} and 10^{-1} mole of pyrene per mole of anthracene and 10^{-2} , 5×10^{-2} and 10^{-1} mole of perylene per mole of pyrene were prepared.

Method of testing :

The pure compounds and phosphors were tested for its El. performance in an El. cell. The emitter was a film of cellophane prepared by dipping it into a hot saturated solution of El. material, drying it, and placing it with melted paraffin wax between a plate of aluminium and sheet of transparent mica of uniform thickness. The cell was compressed before cooling to exclude air bubbles. The sheet of mica was covered with a conducting

glass at the top, served as second electrode. This condenser was enclosed in an ebonate frame provided with a small window in the middle of the top of the surface, and a screw arrangement to adjust the interelectrode distance and the pressure. From the two electrodes, leads were taken out and high electric field was applied to the El. material. The emitted light was observed through the transparent conducting glass.

Electrical and optical measurements :

For intensity measurements, a set up consisting of following components was designed :

- i) a sample holder for an El. cell,
- ii) a constant deviation spectrometer as a dispersing unit,
- iii) a powerpack unit for a photomultiplier tube (make:IP-21 which served as a detector,
- iv) a step up transformer for an a.f. oscillator (Phillips GM, India make) for voltage and frequency variation, and
- v) a sensitive spot reflecting galvanometer (Polyflex) for photomultiplier readings. In order to obtain reproducibility, the excitation condition, (viz. cell spacing, the area of illumination, applied voltage and frequency) were kept under close control.

Spectral energy distribution of El. emission :

The spectral energy distribution (S.E.D.) of pure pyrene, anthracene, perylene and of various phosphors prepared were studied at selected voltages and frequencies. They were

separately used in an El. cell assembly and excited by sinusoidal voltages upto 900 volts (r.m.s.) and with excitation frequencies between 800-2500 cps. In all the materials studied, it was found that λ_{max} is independent of applied voltage and frequency of excitation, over entire range studied. Thus, the λ_{max} remains constant.

The electroluminescence in anthracene has been studied by several workers. These investigations involve electroluminescence of intrinsic as well as extrinsic and arises due to the radiative recombination of electrons and holes injected into the crystal.

The pyrene has been reported to be a highly fluorescent compound and the mechanism of El. emission may take place either by radiative recombination of electrons and holes or most probably by the excimer formation. When the microcrystalline pyrene powder sandwiched between two plane parallel electrodes was excited by a.c. field, some of the molecules were electronically excited. These electronically excited molecules combine with unexcited ground state molecules and form the excimers. The excimer so formed dissociates after El. emission.

The crystal structures of pyrene and perylene are similar, which favours the formation of excimers. Therefore, electroluminescence mechanism of pure perylene seems to be identical with that of pyrene.

Electroluminescence emission in pyrene doped anthracene may be due to energy transfer from anthracene to pyrene. The excited pyrene so formed combine with its unexcited ground state molecule and form the excimer. The excited excimer dissociates after El. emission.

When perylene doped pyrene powder was excited, the El. spectra obtained shows two bands, One a small broad band situated at 5000 \AA° corresponding for weak excimer emission of pyrene and other at 6800 \AA° corresponding for the emission from the emitting level of mixed excimer. Thus, when perylene doped pyrene was electronically excited, the pyrene absorbs energy which is trapped by perylene molecules. The excited perylene may interact with adjacent pyrene molecule and form mixed excimer. The mixed excimer dissociates after El. emission.

Voltage and frequency dependence of El. emittance :

For all the compounds and the phosphors studied, it was invariably observed that for a constant high frequency, the El. brightness (B) increased exponentially with applied voltage V, and seems to saturate at high voltages. The various well established equations for B-V relation were tested and it was found that the equation.

$$B = a \cdot \exp \left(- \frac{b}{V^{0.5}} \right)$$

describing the saturation behaviour is obeyed for all organic materials. The behaviour has been explained on the basis of 'Mott-Schottky' barrier mechanism of El. process. However, at constant smaller values of frequencies, the above relation fails and the El. brightness (B) increases linearly with voltage in accordance with the relation.

$$B = \sqrt{V}$$

At constant voltage, El. brightness increases with frequency and seems to saturate at higher frequencies. The results have been explained on the basis of the phenomenological treatment of electroluminescent build-up process.

The luminous efficiency, seems to depend upon the voltage and frequency of the applied field. For a given organic material optimum efficiency is obtained at a specific voltage and frequency only.