1. Introduction

1.1 Luminescence

Luminescence in solids is the phenomenon in which electronic states of solids are excited by some energy from an external source and the excitation energy is released as light. When the energy comes from short-wavelength light, usually ultraviolet light, the phenomenon is called photoluminescence. Photoluminescence in solids mainly in inorganic and organic insulators and semiconductors is classified in terms of the nature of electronic transitions producing it into two major types, namely intrinsic and extrinsic luminescence.

1.1.1 Intrinsic luminescence

There are three kinds of intrinsic luminescence; (1) band-to-band luminescence (2) exciton luminescence and (3) cross-luminescence

1.1.1.1 Band-to-Band Luminescence

This luminescence mainly occur in very pure crystals owing to the band-to-band transition i.e. due to the recombination of an electron in conduction band with a hole in the valence band particularly at high temperature. This has been observed in Si, Ge, and some IIIb-Vb compounds such as GaAs. Band-to-band transition mainly concerned with light emission from very bright type light emitting diodes and semiconductor lasers.

1.1.1.2 Exciton Luminescence

An exciton is a composite particle of an excited electron and a hole interacting with one another. It moves in crystal conveying energy and produces luminescence due to recombination of electron and the hole. There are two kinds of excitons; Wannier (or Wannier-Mott) exciton and Frenkel exciton. According to Wannier exciton model, this exciton is composed of an electron in the conduction band and a hole in the valence band which are bound together by Coulombs interaction. Thus Wannier exciton is analogous to a hydrogen atom. It moves in a crystal but does not contribute to electric conduction in it. The expense of the wavefunctions of the electron and the hole in a Wannier exciton is much larger than the lattice constant. Wannier excitons are stable only at low temperature where binding energies of excitons are higher than the thermal energy. This model works well for inorganic semiconductors like IIIb-Vb and IIb-VIb compounds. The Frenkel exciton model is used where the expanse of the electron and hole wavefunctions is

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smaller than the lattice constant. The examples of this type of excitons are organic molecular crystals like anthracene, tetracene and inorganic complex salts including transition metal ions. In these materials, the excited state of an isolated molecule or a complex ion transfers from molecule to molecule or from complex ion to ion due to dipole-dipole interaction.

1.1.1.3 Cross-Luminescence

Cross-luminescence is produced by the recombination of an electron in the valence band with a hole created in the outermost core band. This luminescence was first observed in BaF_2 under X-ray pulse excitation in 1982.Cross-luminescence can take place only when the energy difference between the top of the valence band and outermost core band is smaller than the bandgap energy. A notable characteristic of this luminescence is its faster decay time that enables it to be used as scintillators. Cross-luminescence is observed in number of alkali and alkaline earth halides.

1.1.2 Extrinsic Luminescence

Extrinsic luminescence is caused by intentionally incorporated metallic impurities or defects. Intentionally incorporated impurities are called activators and materials made luminescent in this way are called phosphors. Extrinsic luminescence in ionic crystals and semiconductors is classified into two types; (1) unlocalized type and (2) localized type. In the unlocalized type, the electrons and holes of the host lattice participate in the luminescence process. While in case of the localized type the luminescence excitation and emission processes are confined in a localized luminescence center. In semiconductors most important impurities are donors and acceptors which act as luminescence activators. Donor-acceptor luminescence is caused in two ways; the first is that after the band-to-band excitation an electron is trapped at an ionized donor, and a hole at a compensated acceptor and they recombine. The second is direct excitation of an electron in a compensated acceptor to an ionized donor level. Hence donor-acceptor luminescence is regarded as an intermediate between localized and unlocalized type. The emission energy of this luminescence depends on the spatial separation between the donor and the acceptor in a pair.

1.2 Fluorescence

Fluorescence is result of three stage process that occurs in certain molecules such as polynuclear aromatic hydrocarbons or heterocycles;

1.2.1 Excitation

A photon of energy $h\upsilon_{ex}$ is supplied by a uv-visible radiation source such as an incandescent lamp or a laser and absorbed by the atom under consideration, creating a vibronically excited electronic singlet state (S_1*). The excited state exists for finite time (1×10^{-9}sec). During this time molecules undergo conformational changes and are also subject to magnitude of possible interactions with its molecular environment. These processes have two important consequences. The energy of S_1* is partially dissipated yielding excited singlet state (S_1) from which fluorescence emission originates. It is also likely that all the molecules initially excited by absorption do not return to ground state (S_o) by fluorescence emission. Other processes such as collisional quenching, fluorescence energy transfer and intersystem crossing may lead to depopulate S_1 states. It is therefore necessary to review all possibilities that the excited state molecule undergo before exhibiting fluorescence. All such processes are depicted in the Jablonski diagram shown in Fig.1

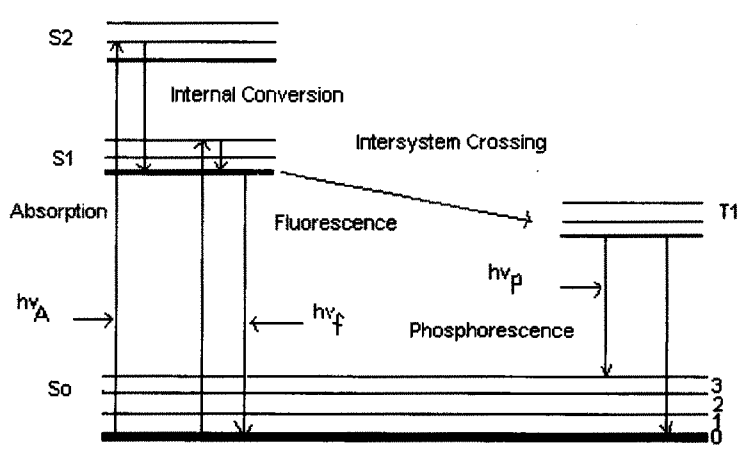

Fig. 1 Jablonski Diagram.

1.2.2 Vibrational relaxation (VR)

It is shown that the energy emitted by the excited molecule as fluorescence is always less than the energy absorbed from excitation photon. This has been proved

experimentally that the emission spectra of solids and solution are always red shifted from the corresponding absorption spectra. The fluorescence typically occurs at lower energy or longer wavelength. The difference in energy in wave number is known as Stoke shift. This phenomenon was first observed by Sir G. G. Stokes in 1852 at the University of Cambridge [1].

N. Balamurugan et al reported luminescence properties and growth of pure and anthracene doped naphthalene crystals with a high quality 20mm diameter and 60mm length by self seeded Vertical Bridgman method [2]. XRD and Raman analysis show that the guest molecules appear as defects in the form of irregular oriented molecules that do not significantly distort the monoclinic structure. The absorbance and fluorescence studies show high Stokes shift for anthracene doped naphthalene crystal. From this we deduce that the exciting wavelength for the light (270nm) is completely absorbed by naphthalene so that fluorescence from anthracene takes place as a result of energy transfer from naphthalene. Further Kasha predicted that the fluorescence always arise from the lowest vibrational level of the first excited singlet state. It is believed that the excess vibrational energy of the excited molecule is dissipated non-radiatively in the form of IR quanta or in the form of kinetic energy imparted to other molecules with which it collides. Thus it will be thermally relaxed to lowest vibrational level of the electronically excited singlet state within lifetime of 10^{-14} to 10^{-12} sec. This overall non-radiative process is vibrational relaxation (VR).

1.2.3 Fluorescence

The thermally relaxed molecule in zeroth vibrational level of S_1 state can return to any one of the vibrational-rotational levels of the ground state with the emission of light. This radiative emission is referred to as fluorescence. The fluorescence arising during the excitation of the system is known as prompt fluorescence or steady state fluorescence. In some cases the fluorescence may arise as a glow for short period of time when excitation is cut off, such emission is referred as delayed fluorescence. Subsequent to emission, thermal relaxation occurs in 10^{-12} sec., with the molecule ultimately arriving in the lowest vibrational level of the ground state.

The vibrational relaxation processes in the excited state occur after light absorption, they are not reflected in the electronic absorption spectra. Similarly because vibrational

relaxation processes in the ground state occur subsequent to light emission, they are not reflected in the fluorescence spectra. Since all absorptions are considered to arise from the same vibrational level of the ground state and terminate in the various vibrational levels of the excited state (unrelaxed or Franck-Condon excited state), the absorption spectra reflects the vibrational structure of the Franck-Condon excited state. All fluorescence arises from the same vibrational level of the lowest excited singlet state and terminates in various vibrational levels of the ground state (Franck-Condon ground state); the fluorescence spectrum reflects the vibrational structure of the Franck- Condon ground state.

The vibronic transitions in absorption and fluorescence spectra which correspond to the transitions between the lowest vibrational levels of the ground state and the lowest vibrational levels of the excited state (0←0) are identical in energy and correspond to long wavelength vibronic feature of the longest wavelength absorption band and the short wavelength vibronic feature of the fluorescence band. If the Franck-Condon ground and lowest excited singlet states have the same vibrational structures (i.e. the vibrational spacing are same in both), the fluorescence and longest wavelength absorption bands will be mirror images of each other, with the absorption spectrum lying on the long wavelength side of the (0←0) band. However owing to the differences in the charge distributions in the ground and excited states, the vibrational structures of these states are often somewhat different, so that at best an imperfect mirror image relationship frequently results.

1.2.4 Processes competing with fluorescence

Although process of fluorescence is simple occurring after absorption of photon by a molecule and its subsequent release to ground state in the form of light seems to be straightforward there are certain nonradiative processes which competes with fluorescence process.

1.2.4.1 Internal Conversion (IC)

Once an excited molecule has relaxed to the lowest vibrational level of the electronically excited state, it can dissipate excitation energy only by going to lower electronic energy level. This can be achieved in one of three possible ways. If there is a considerable overlap between the lower vibrational levels of the higher electronic state

and higher vibrational levels of the lower electronic states then the upper and lower electronic states will be in a transient thermal equilibrium, which will allow population of the lower electronic state. Finally, the molecules crossover from higher to lower excited singlet state by this vibrational coupling. If there is no considerable overlap but they separated by a small gap, the molecule in the upper electronic state will convert to the lower electronic state by tunneling mechanism.

Lastly, if the energy separations of the upper and lower electronic states are relatively large, the radiative transition takes place to the any one of a number vibrational levels of the lower electronic state. This radiative transition is nothing but the fluorescence. Internal conversion process is very rapid, taking about 10^{-12}sec. The average lifetime of the lowest excited singlet state is of the order of 10^{-8}sec. Therefore even if a molecule cannot pass efficiently from its lowest excited singlet state to the ground state, it may undergo processes which may compete with fluorescence as explained earlier.

1.2.4.2 Intersystem Crossing (ISC)

This is the process in which the vibrational coupling between energy states of the different multiplicity. Population of triplet state by direct absorption from the ground state in many aromatic molecules occurred within the lifetime of an excited singlet state (10^{-8}sec.). This process is spin dependant internal conversion which is referred as intersystem crossing.

For the efficient population of triplet state molecule should have to satisfy following conditions:

1) The energy difference between the lowest singlet state and the triplet state just below it must be small.
2) Vibrational coupling should be more between the excited singlet state and triplet state.

In aromatic hydrocarbons where the singlet triplet splitting is large, the ISC is less efficient than in certain dye molecules where triplet-triplet splitting is small. Once ISC has occurred, the molecule undergoes the usual IC process and falls to the lowest vibrational level of the first excited triplet state. Therefore ISC can compete with fluorescence and thus it decreases the quantum efficiency of fluorescence. The population

of triplet state has significance in producing delayed fluorescence and phosphorescence, which is a radiative decay of triplet state molecule to the ground state.

1.2.5 Fluorescence and structure of organic solids

Though nearly all molecules are capable of absorption, the fluorescence is not observed in large number of compounds. Fluorescence is generally observed in those organic molecules which have rigid framework and not many loosely coupled substituents through which vibronic energy can flow out. Most organic fluorescent molecules contain conjugated system of double bonds with extended π-orbital in a planer cyclic structure. Such structure imparts certain rigidity to the molecule and shifts the absorption and emission wavelengths in the visible region. The compounds which absorbs at a higher energies than the strengths of their weakest bands do not fluoresces.

1.2.5.1 Aromatic hydrocarbons

These crystalline materials; differ considerably from their solution fluorescence. In dilute solutions emissions are observed from the singlet excited molecule and the observed monomeric emission is the molecular property. However in crystals the emission observed is a property of the crystal as a whole. The emission may not be a molecular property depends on the way by which molecules are packed in molecular crystal lattice. Such emissions can not be regarded as a molecular phenomenon because the energy levels involved are not of those of a single molecule but those of the aromatic hydrocarbons are the molecular solids and emission is observed from crystal lattice [3]. These compounds are fluorescent due to large energy separation between excited singlet S_1 and triplet T_1 states as intersystem crossing is less probable in such system. Fluorescence efficiency increases with increase in number of condensed rings like benzene ‹ naphthalene ‹ anthracene. Linear ring systems are good fluorescer as compared to angular compounds like phenanthrene. Polarity of the ring is an important criterion. Substituents which produce steric hindrance to planarity reduce π-electron mobility and lower the fluorescence efficiency of the molecule.

Substituents have considerable effect on emission characteristics of aromatic compounds. Heavy atom substituents tend to reduce the fluorescence quantum yield Φ_f in favor of phosphorescence emission Φ_p. In halogen series effect goes on increasing in order of f ‹ Cl ‹ Br ‹ I.

In the non-linear molecules such as phenanthrene, 1,2-benzanthracene the benzenes are cross linked. Such cross linkage increases the difference between lowest excited singlet and ground state. The energy difference in phenanthrene is more than in anthracene. Therefore the wavelength of longest fluorescence band of phenanthrene is shorter than that of the anthracene. Similarity, in 1,2-benzanthracene the wavelength of longest fluorescence band is shorter than that of the anthracene.

1.2.5.2 Heteroatomic molecules

In heteroatomic molecules (π-π^*) and (n-π^*) energy states have different emission probabilities. Since fluorescence is generally observed from the lowest energy excited state of the same multiplicity as the ground state, nature of this state will dictate chemistry of molecules.

If for a heterocyclic molecule ^{1}(n-π^*) state is lowest excited state, because of the space forbidden character of this transition, a longer life and small rate constant for emission is expected. Hence pyridine, quinoline and acridine which are isoelectronic N-analogs of benzene, naphthalene and anthracene are nonfluorescent in hydrocarbon solvents. But in those compounds in which ^{1}(π-π^*) and ^{1}(n-π^*) are not very far apart, polar solvents bring about change in order of the energy levels, making ^{1}(π-π^*) state as the lowest excited level with appearance of fluorescence.

1.2.5.3 Peri-condenced molecules

They are most conjugated and complex molecules having more than three benzene rings cross linked with each other. The angular linkage decreases the energy of the lowest singlet state to a greater extent. Hence emission in such molecules occurs at longer wavelength. The fluorescence spectrum is shifted towards red showing a large Stoke shift. These molecules in crystalline state don't exhibit monomeric emission as in the case of linearly and non-linearly condensed molecules. The monomeric emission in peri-condensed molecules is possible from the dilute solutions or from the vapor state of these compounds.

Crystal fluorescence spectra of the peri-condenced molecule undergo a pronounced red shift and loss of vibrational structure in comparison with corresponding molecular fluorescence observed in solution. This is attributed due to much closer spacing and larger overlap of molecular planes in different types of crystal lattice. The overlap of

molecular planes promotes very strong interactions and it is believed that the spectrum of the crystal emission is a diagnostic of the type of molecular lattice adopted. Aromatic hydrocarbons appear to crystallize with two distinct types of lattice according to their molecular dimensions. Those molecules like naphthalene, anthracene, phenanthrene etc adopt 'A' type lattice, in which the aromatic plane has both long and short axes and large angle of inclination of the molecular planes to the symmetry planes of the crystal puts limit on the π-orbital overlap of adjacent parallel molecules. In these crystals weak coupling between the molecules in the lowest excited singlet state is small compared with intermolecular energy and exhibit a slight red shift of the fluorescence spectrum in which molecular vibrational structure is preserved.

The disk-shaped molecule of pyrene, perylene and 1,2-benzperylene on the other hand have the lattice structure of type 'B' where the lattice unit is a pair of almost completely overlapping parallel molecules with an interplaner distance of 3.5A^{o}. The observed fluorescence spectra are sensitive to the penetration depth of the exciting light and the geometry of the exciting system.

For complete understanding of the crystal fluorescence the observed emission spectra can be classified into three main classes-

a) Sharp-S
b) Broad-B
c) Diffuse-D

Most of the linearly condensed molecules produce 'S' type crystal emission, non-linearly condensed molecule show 'SB' type crystal emission. Chrysene exhibit 'B' type crystal emission whereas peri-condensed molecules show a 'D' type crystal emission.

1.2.5.4 Dyes

The guest-host doped system has been reported to give bright electroluminescence by Tang [4] .The emission color in these cells can be changed and the brightness is increased by doping the emitter (host) layer with highly fluorescent dyes (guest). The fluorescent dyes in a dilute solution generally have high photoluminescence (PL) quantum yield. But the dye in concentrated solution shows the concentration quenching effect. The dye film also shows the concentration quenching effect and excimer emission due to red shift. Therefore the dilute fluorescent dye in the host emitter layer as solvent has high PL and

EL quantum yield. This system makes the most of highly PL and EL quantum yield of dopant dyes.

1.3 Concept of mixed crystals

Fluorescence of aromatic hydrocarbons is susceptible to presence of impurity. Incorporation of impurity emitting at longer wavelength in pure organic materials having emission towards lower wavelength gives a mixed crystal system emitting at longer wavelength. The intentional incorporation of impurity in host is done by doping technique. Doping is carried out with a hope that the basic solid sample with some other compound may give desired effect due to presence of a foreign molecule in the host material or simply to tune the property of material [5]. This kind of doping experiment is often made by growing a mixed crystal from melt or saturated solution to which a known amount of dopant has been added. In such experiment one should be aware of the solubility limit in the solid state. Aromatic compounds such as naphthalene, biphenyl, anthracene etc in their molten states are quite good solvent matrix for many organic dopants just like benzene, toluene, and xylene in solution states. By selecting properly the fluorescent impurities it is possible to prepare organic polycrystals emitting towards red of the visible spectrum. It is necessary that the host and guest impurity should be isomorphous materials. In such systems molecules of similar size can replace each other indiscriminately in the crystal lattice. A mixed solution of isomorphous substances deposit crystals which may contain a wide range of properties of the isomorphous substances. The cell dimensions are intermediate between those of the pure substances. The emitted light is characteristics of either guest monomer or excimer fluorescence or exciplex or a charge transport complex is formed between host and guest molecules in the excited state. Formation of these intermediate species could be demonstrated by fluorescence and absorption spectroscopy. The mixed crystals are prepared by using doping technique.

1.3.1 Preparation of mixed crystals

Preparation of doped organic mixed crystals differs considerably from that of doped inorganic mixed crystals. The doping method for inorganics consists of taking the appropriate amounts of base materials, activators, co-activators mixing them intimately in ethanol and drying at 70^0C. The mixture is fired at elevated temperature (700-960^0C) in

silica crucible in the furnace under different gas atmosphere. The fired content is cooled, finely powdered and tested for its photoluminescence performance [6, 7].

High purity organic semiconducting materials are used for synthesis of light emitting organo-luminophors. The method consists of heating the calculated amounts of host and guest in silica crucible placed in closed electric furnace. The solid state reaction between the components gives the homogeneous molten masses, which is then cooled in an inert atmosphere to grow mixed crystals. The process of heating and cooling to be repeated three to four times to obtain homogeneous mixed crystals. The slow controlled cooling process is preferred in the mixed crystal preparation methods used by Misra and McGlynn [8]. The method uses sealed Pyrex tubes as a container for the mixture of components and a Bridgemann furnace for heating of the contents in a Pyrex tube. The temperature was monitored by the pyrometer.

1.3.2 Literature

O. Pekcan reported preparation of pyrene doped fluorene crystals where triplet state energy transfer in a pyrene-d10 doped fluorene single crystal was investigated by ESR [9]. The yellow-green mixed crystals of 2,3-dimethyl naphthalene (DMN) doped with tetracyanobenzene (TCNB) and anthracene doped with TCNB were also grown by evaporation of acetone from solution containing an equimolar mixtures of TCNB with DMN [10]. The literature reveals the preparation of anthracene co-crystals doped by pthalocyanine by co-crystallization method [11].

A. Nicolet et al reported preparation of doped polycrystalline samples of anthracene containing small amounts of terrylene. Their method consists to heat both host and impurity to obtain melt which further quenched in a small glass tube quickly dipping into water [12].

N. Balamurugan et al have prepared anthracene doped naphthalene crystals exhibiting scintillation characteristics by using selective self seeding Bridgemann method [2].

Kunihir et al have reported mechanochemical doping of tetracene into anthracene crystals by milling technique [13]. The wet bead milling of anthracene with tiny amounts of tetracene in water results in mechanochemical doping to exhibit solid state singlet energy transfer. Changes of emission spectra are sensitive to milling conditions so that couple can act as a fluorescent probe for milling. Perylene displays similar behavior

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whereas pentacene and rubrene lead to insufficient fluorescence quenching due to their poor solubility in host crystal.

1.3.3 Structural Aspects of Mixed Crystals

Structural features of the mixed polycrystals were studied by X-ray diffraction (XRD) the information's regarding homogeneity of mixed crystals, crystallanity and particle size are obtained from XRD profile of the crystalline powders.

S. S. Chavan et. al. reported XRD studies of 2-[2'-hydroxysalicylidene-5'-(2''-thiazolyazo] benzoic acid to illustrate structural information. The structure of the organic sample was found to be tetragonal belonging to non-primitive system. The strain broadening effects are also examined [14].

1.4 Fluorescence quenching by Excitation Energy Transfer (EET)

A quenching process is defined as one which competes with the spontaneous emission process and thereby shortens the lifetime of emitting molecule. These quenching reactions are energy transfer or electron transfer processes. The lifetime of emitted species is shortened may be due to formation of transient complex in excited state called exciplex or may be due to complex formation in ground state in case of solution called as static quenching. In static quenching ground state complex formation reduces fluorescence intensity by competing with uncomplexed molecule for the absorption of incident radiation which is called as inner filter effect.

During energy transfer between molecules an excited state donor D* transfer its energy to an acceptor A, leaving the acceptor in an excited state A*.

$$D^* + A \rightarrow D + A^*$$

In doped thin films, this can manifest itself as a host transferring the excitation energy to a dopant molecule. The energy transfer results in the quenching of the donors luminescence and increasing of the dopants luminescence [15].

According to perturbation theory, there are two types of energy transfer mechanisms:

I. Forster type including electronic interaction.

II. Dexter type with an electron exchange.

1.4.1 Forster energy transfer

Fluorescence resonance energy transfer or Forster resonance energy transfer describes an energy transfer mechanism between two fluorescent molecules. A fluorescent donor

(D) is excited at its specific fluorescence excitation wavelength. This excited state is non-radiatively transferred to a second molecule generally known as acceptor (A) by a process of long range dipole-dipole coupling. This donor is then returned to the electronic ground state by a non-radiative process termed as fluorescence resonance energy transfer (FRET) after the German scientist Theodor Forster.

The electrostatic interaction can be expressed as a sum of multipole-multipole interactions. Forster determines that rate of energy transfer K_{ET}, depends on the distance R between donor and acceptor molecule and is given by [16]

$$K_{ET}(R) = \left(I/\tau\right)\left(Ro/R\right)^6$$

Where, Ro is Forster medium and τ is average lifetime for recombination in the absence of energy transfer. If R=Ro then probability of exciton recombining at the donor is equal to the probability of energy transfer occurring. The distance Ro is given by the following integral taken over the all energies, hυ [15].

$$Ro^6 = 1.25 \times 10^{17} \, \Phi_E / n^4 \int FD(\nu) \Phi \alpha_A(\nu) \partial \nu / \nu^4$$

Where Φ_E is the quantum efficiency of the donor emission, 'n' refractive index of the host, F_D is the normalized emission spectrum of the donor, and α_A is normalized absorption cross section of the acceptor. Forster transfer can be long range process with transfer process up to 100A° in some organic species [15].

In Forster energy transfer the spin of both states must be (acceptor and donor) conserved, which leads to following allowed transitions [15].

$$^1D^* + {}^1A \rightarrow {}^1D + {}^1A^*$$

$$^1D^* + {}^3A\,(Tn) \rightarrow {}^1D + {}^3A^*\,(Tm)$$

The triplet state transition,

$$^3D^* + {}^1A \rightarrow {}^1D + {}^1A^*$$

is forbidden [15].

Arkhipov et al have reported quenching of excitons in doped disordered organic semiconductors by formulating various models of exciton quenching at charge transfer centers and by Forster energy transfer [17]. This model considers quenching as a diffusion limited process with exciton diffusion rate gets controlled by energy relaxation

of excitons within the inhomogeneously broadened intrinsic excitonic density of states. The calculated dependence of the radiative exciton decay rate upon density of dopant are used in order to fit experimental data on the Forster type fluorescence quenching in poly (phenylphenylene vinylene) and photoluminescence quenching at charge transfer centers in an alkoxy-substituted poly-phenylenevinylene.

The FRET efficiency is determined by three parameters:

1) The distance between the donor and acceptor: The probability of excitation energy transfer is examined by determining critical energy transfer distance (Ro) using Forster relation [18]. Here region of overlap between emission spectrum of host and absorption spectrum of guest is used to estimate value of integrated overlap area. The value of Ro less than 50A° indicates efficient transfer of energy between host and guest molecules [19].

2) The spectral overlap of the donor emission spectrum and the acceptor absorption spectrum: The process of EET also occur favorably if there is larger region of overlap between emission spectrum of host (donor) and absorption spectrum of guest (acceptor).

3) The relative orientation of the donor emission dipole moment and the acceptor absorption dipole moment.

Richard C. Powell reported energy transfer in anthracene and tetracene-doped naphthalene crystals, using fluorescence spectroscopy [20]. In these system is not explained on the basis of theory of exciton diffusion related with molecular crystals. However time dependence is concerned with the predictions of long-range resonance transfer, but in anomalously long interaction strength is same for both types of impurity molecules despite the fact that there is a significant difference in the overlap of their absorption spectra with the host emission spectrum. Similar measurements were made on energy transfer of anthracene molecules to tetracene molecules in a naphthalene host. In this case, the mechanism for energy transfer is expected to be long-range resonance interaction and is found that data can be fitted with the predictions of this theory using theoretically derived value for the strength of the interaction.

M. D. Galanin et al reports energy transfer in tetracene doped anthracene crystal using single photon counting technique, where they reported that the transfer of energy is due to both free and trapped electrons [21]. This energy transfer is prototypical

phenomenon in molecular crystals manifest in the quenching of the host luminescence by traces of inadvertent impurities or deliberately added dopants. It occurs via exciton migration. Here exciton retains its identity as strongly bound electron-hole pairs until they decay radiatively at the trap. During this study emission intensity of dopant (sensitizer) is recorded as a function of its relative concentration [22]. S. L. Bhattar et al reported FRET between perylene and riboflavin in micellar solution of sodium dodecyl sulphate [23]. The fluorescence of perylene is quenched by riboflavin in accordance with Stern-Volmer kinetics. The estimated value of Ro is less than 50A° indicating efficient transfer of excitation energy.

Ralph et al reported current induced fluorescence quenching in organic light emitting diodes with a doped Alq [tris (8-quinolinolato) aluminium] as an emitting layer [24]. Here the electroluminescence quantum efficiency of organic light emitting diodes is found to decrease with increasing current density. This phenomenon was investigated using multilayer device structures permitting bipolar or unipolar carrier transport and luminescence measurements with simultaneous optical and electrical excitation. The loss of electroluminescence quantum efficiency is attributed to the quenching of the singlet-excited state of the dopant by a cationic species.

Y. Wu et al reported excitation energy transfer between tris-(8-hydroxyquinoline) aluminum (Alq_3) and a red dye 4-(dicyanomethylene)-2-methyl-6-(p-dimethylamino-styryl)-4H-pyran (DCM) by means of in situ measurements of photoluminescence of bilayer Alq_3/DCM films with various Alq_3 thickness [25]. It is found that exciton diffusion in Alq_3 and Forster energy transfer from Alq_3 to DCM are contributive to PL spectra measured. A rate equation model based on these two processes is derived and used to fit experimental results. The Forster energy transfer radius obtained for the system is Ro=3.3nm.

1.4.2 Dexter energy transfer

It is simply electron exchange. It is triplet singlet transition which is not allowed.

1.5 Fluorescence quenching by excimer formation

An excimer forms when an excited state molecule interacts with ground state molecule of the same type, resulting in a species with an overall lower energy [26]. In almost cases, the emission is red shifted compared to the emission from the excited state

molecule. Excimers were first observed in pyrene solutions by Forster and Kasper in 1955 [27].

Excimer formation in solids is related to the formation of aggregates. The main difference between the two is that for aggregates both emission and absorption spectra are shifted. The emission shift in aggregates can be either red or blue depending on orientation of the transition dipoles of the component system [26].

The effect of molecular shape, on packing pattern of aromatic hydrocarbons was given by Robertson [28] while Stevens [3] suggested that crystal fluorescence spectra can be indicative of intermolecular π-orbital interaction. The excimer fluorescence is more favorable in crystals than in a dilute solution as π-orbital overlap of adjacent molecules is negligible. Benzene and its alkyl derivatives, naphthalene and its derivatives form excimers. The planer structures of these compounds lead themselves to easy association with neighboring molecule and a resonance interaction takes place between two molecules. In these compounds the molecular planes are separated by 3-4A° [29]. In anthracene because of its molecular geometry, ground state dimer formation is favorable rather than the excimer. 9-methylanthracene on the other hand favors excimer formation [30]. An extensive work has been done to investigate excimer of pyrene under different environmental conditions along with the kinetic studies regarding the rate of formation of excimer and its emission [31].

Earlier reports from our laboratory are on quenching of excimer fluorescence of pyrene by perylene dopant. The presence of perylene in pyrene crystal quenches excimer electroluminescence of pyrene and characteristics emission due to pyrene-perylene molecular interaction is shown to occur by electroluminescence spectroscopy [32].

It is reported that fluorescence spectrum of pyrene doped fluorine is broad structureless with maximum at 470nm. The emission bands of fluorine are not observed in fluorescence spectra of pyrene doped fluorine. From this observation it was concluded that the pyrene quenches the monomeric emission of fluorine and observed broad emission is well known pyrene excimer emission [33].

It is discovered that as the concentration of pyrene increases the fluorescence shifts towards lower energies and spectrum becomes broader. The absorption spectra remain unchanged. In such experiments the monomer fluorescence seen in dilute solution is

quenched successively with concentration due to excimer fluorescence. Similar types of results are also observed in pyrene doped polymer thin films when concentration of dopant is increased [34].

1.6 Fluorescence quenching by exciplex formation

Exciplexes are dimers of two dissimilar molecules that may exist in the heterostructure [35]. In some systems of organoluminophors when one compound is added into other the mixed excimer is formed. It has been shown that the excited monomeric species associate with an unexcited molecule of a different compound and form mixed excimer as

$$A^* + B \leftrightarrow (AB)^*$$

Birks and Christophorou proposed the term 'exciplex' for such mixed excimer [36]. The dissociation of exciplex is accompanied with emission of visible light and formation of ground state molecules of two compounds. It is noted that observed emission is characteristics of exciplex and does not correspond to emission of individual compounds between which exciplex is formed.

Exciplex fluorescence of poly (N-vinylcarbazole) film doped with diethyl terepthalate is reported by Yokoyama et al [37]. The results are interpreted in terms of field assisted thermal dissociation into free carriers from the nonrelaxed exciplex state, which provided an insight into the extrinsic carrier photogeneration in organic molecular crystals.

It has been reported that the formation of exciplex at organic solid interface is significant from both the scientific and technological viewpoint. Tuning of emission color in organic EL devices using exciplex formation is also reported since the wavelength of exciplex emission varies with ionization potential of electron donor and electron affinity of the electron acceptor [38].

In the solid state monomer of two components must be nearest neighbors for an exciplex to form and closest distance of approach between them should be less than 50A°. This is easily achieved in doped crystalline luminophors as there are always domains where two molecules are the nearest neighbors. The formation of complex between donor and acceptor occur either by charge transfer, electron transfer or molecular aggregation. The charge transfer is always a diffusional process and favorable only in solution containing donor-acceptor system. In solid the diffusion of electron is not

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probable hence exciplex formation must be due to lateral π-orbital overlapping of donor with acceptor [39]. Pujari et al reports the exciplex formation and emission between pyrene and perylene in fluorene matrix [34]. The addition pyrene and perylene shown to quench the structured monomeric emission of fluorine and a new structureless emission band appear which may arise due to emission from the exciplex formed between pyrene and perylene.

Jadhav et. al. reported exciplex emission of crystalline biphenyl doped by pyrene at various concentrations of pyrene [40]. The increase in concentration of pyrene quenches the structured monomeric emission of pyrene due to nonradiative energy transfer from excited pyrene to biphenyl moiety.

Je- Seung Kim et al reported the achievement of white organic electroluminescent (EL) device through exciplex formation between organic materials as a green color light source [41]. The exciplex formation at 500nm originated from poly (N-vinylcarbazole) (PVK) and 2,5-bis (5-tert-butyl-2-benzoxazolyl) thiophene (BBOT), exciplex formation at 550nm between N,N`-diphenyl-N,N`-bis (3-methylphenyl)-1,1`-biphenyl-4,4`-diamine (TPD) and BBOT was assumed to correspond the complex formation covering the green color region. In the mixed emitting materials, the PL decay lifetime of BBOT and poly (3-hexylthiophene) (PH_3T) were increased as much as 35-68 and 1.5-19ns respectively. These results indicate that energy transfer occurred from PVK to BBOT and P_3HT enhancing the quantum efficiency of these materials. Thus white light emission with brightness of 12.3μW/cm^2 at 20V was achieved.

Exciplexes are observed for bis (2-(benzimidazole-2-yl) quinolinato) zinc with N,N`-bis-(1-naphthyl)-N,N`-diphenyl-1,1`-biphenyl-4,4`-diamine(NPB) system, in both electro and photo luminescent properties. The identification of exciplex emission in co-evaporated and multilayer ZnBIQ thin film was reported. The optical formation of the exciplex involves the excitation of a single molecule, followed by the relaxation of that exciton into a lower energy exciplex state. Both BIQ and ZnBIQ possess very high thermal stability [42].

1.7 Fluorescence quenching by electron or charge transfer

Electron exchange or charge transfer requires the approach of acceptor molecule to a distance slightly greater than the molecular radius of donor molecule. The electron

exchange also needs the overlap of the electronic wavefunctions of donor and acceptor and it is therefore short-range process. During the exchange spin must be conserved. When donor and acceptor system is irradiated by UV source the absorption results in the extraction of an electron from the donor, which results into positively charged donor (D^+). The extracted electron when added to an acceptor, the negatively charged acceptor is formed (A^-). Thus the result of electron exchange process is the formation of ion-pair (D^+- - - A^-). The ion-pair is a short lived species and is known as exciplex or charge transfer complex. The exciplex or CT complex decay radiatively and their characteristics fluorescence emission appears in the spectra as a broad tail to the red side of the spectrum. It is interesting to note that the observed emission is characteristics of exciplex and does not correspond to the emission of individual compounds between which exciplex is formed. The formation of CT can occur in solid as well as solution.

Charge transfer process can occurred intramolecularely in the case of molecules consisting of two moieties an aromatic one functioning as light absorber and electron donating or accepting one respectively. At the present time intramolecular charge transfer processes are investigated intensely. Regarding bichromophoric compounds as an anthryl moiety the phenomenon of charge and energy transfer have been dealt within a recent review article of Becker [43].

Molecularly doped polymers contain a strong donor or acceptor molecule in polymer host. Hole or electron transfer occurs by transfer of charge from states associated with the donor or acceptor molecule respectively. This can be described as a one electron oxidation-reduction process [44, 45 and 46].

Hua Wang et al reported that exciplex formation in nonpolar and moderately polar solvent occurs due to exothermic electron transfer reaction or of the efficient coupling of the amine lone pair with 9-cyanoanthracene π-orbital and in polar solvents molecular structure corresponds to a solvent separated radical ion pair formed by intermolecular electron transfer, where energy is dissipated via back electron transfer (BET) without fluorescence emission. A new, blue shifted emission band appears in the region of local emission band which may originate from ground state charge transfer conformer [47].

1.8 Experimental Observables

Most of the doped organoluminophors are used as emitter in organic light emitting diodes (OLEDs) and some intense luminophors as scintillators. Suitability of luminophors for such applications is generally dictated on the basis of the absorption, luminescence and structural studies of the emitting materials. In the field of optical and structural characterization of emitting materials following experimental observables were found to be used by many research workers;

1.8.1) Absorption spectra

1.8.2) Excitation and Fluorescence spectra

1.8.3) X-Ray diffraction spectroscopy

1.8.1 Absorption spectra

The quantization condition for the absorption or emission of light by an atom or by molecule is given by Einstein relation:

$$h\nu = hc/\lambda = E_2 - E_1$$

Where, E_1 and E_2 are the electronic energy levels, 'h' is Planks constant and υ, c & λ are the frequency, wavelength and velocity of the incident photon respectively.

The absorption of energy by a molecule is governed by the Beer-Lambert's law. According to the law,

$$Log_{10}\left(Io/I\right) = \varepsilon.c.l$$

where,

Io = Intensity of incident light

I = Intensity of transmitted light

ε = molecular extinction coefficient

c = concentration of the solution

l = path length of the absorbing system through which light passes and

Log_{10} (Io / I) = Optical density or absorbance of the material.

In practice, the absorption spectrum is plotted in terms of molecular extinction coefficient against frequency or wavelength.

The probability of the absorption depends upon the degree of overlap of the wavefunctions of the lowest vibrational level of ground state s_0 and the wavefunctions of the vibrational levels of the first excited singlet state S_{10}-S_{1n}.

The positions of the absorption peaks and its nature are of significance in the spectroscopic studies. The nature of the absorption spectrum indicates the monomeric or dimmeric state of the molecular systems, which is of importance to explore whether the ground state dimmer or a monomer is excited in the absorption process. In solution the broad absorption band is an indication of dimmeric nature of molecules in the ground state while the structured spectrum indicates the existence of monomolecular species. But in solids the absorption spectra are not as structured as in solution. The nature of absorption bands also give an idea about the lattice structures of molecular systems under study and suggest the possibility of formation of dimmeric species.

Extensive work has been carried out to establish exact relationship between absorption and emission properties of organic crystalline materials with a view to explore electronic and molecular structure of materials in condensed state.

The position of the absorption bands in the spectra of aromatic hydrocarbons depends upon the number of benzene rings and the way by which they are condensed. In linearly condensed molecules, longest wavelength band of absorption spectrum moves towards longer wavelength of the electronic spectrum. This effect is mainly due to decrease in energy difference between lower excited and ground state of the molecule. As number of condensed rings increases this energy difference becomes progressively less in the linear polynuclear aromatic hydrocarbons. But in non-linear hydrocarbons the situation becomes reverse. The energy difference in general increases as the number of bends (angular condensation) in the molecule increases.

1.8.2 Excitation and Fluorescence spectra

1.8.2.1 Excitation spectra

Absorption and emission spectra serves a lot of information about the excited state and ground state vibrational levels. In addition to this a further means of gaining knowledge about the excited states of organic molecules is from the excitation spectrum of the system. An excitation spectrum is obtained by observing the variation in the fluorescence quantum intensity with change in excitation wavelength.

For most of the organic molecules the quantum yield is independent of excitation wavelength because of the very efficient process of internal conversion from higher excited states to the lowest excited singlet state. Even for those molecules excitation spectra provide a powerful tool for measuring the absorption spectra of the molecules even if the concentration is too low to be detected by conventional absorption spectrometry. In case of solid crystalline organic material, excitation spectrum will be identical to the absorption spectrum provided.

$$\varepsilon_1 \langle\langle\langle 1$$

The measurement of quantum intensity, in case of absorption spectrometry depends on the sensitivity of spectrofluorometer, which is ultimately governed by the accuracy with which the intensity of the sample beam is measured with respect to the almost equal reference.

1.8.2.2 Fluorescence spectra

The molecule is in the lowest vibrational level of the ground state at room temperature and on absorption of visible or ultraviolet radiation the molecule gets excited to the higher electronic energy level. This transition occurs too rapidly within 10^{-15} sec. The molecule now has the possibility to drop down to the ground state with the emission of light. The fluorescence always takes place from the lowest vibrational level of the first excited singlet state and the shape of the fluorescence emission spectrum is independent of the wavelength of the exciting light.

The fluorescence emission spectrum is obtained by irradiating the sample by a wavelength of maximum absorption is indicated by absorption spectrum of the sample. It is observed that the absorption spectra gives data about the vibrational levels of the excited state and the emission spectra yields data about the vibrational levels of the ground state. In most of the organic materials the emission spectrum is the mirror image of the absorption spectrum.

1.8.3 X-ray diffraction spectroscopy (Structural studies of luminophors)

X-ray Powder Diffraction (XRD) is an instrumental technique devised by Debye and Scherer in Germany 1917 and used to yield structural information about crystalline materials. XRD is particularly used to identify fine grained materials. In case of mixtures XRD can determine proportion of these materials. Further it can also give information

regarding degree of crystallanity of materials, possible deviations of the materials from their ideal composition (presence of element substitution and solid solution), the structural state of materials and the degree of hydration for materials that contain water in their structures.

The peaks obtained in X-ray powder diffractogram represent positions where the X-ray beam has been diffracted by the crystal lattice. The set of d-spacing (distance between adjacent planes of atoms) represents unique 'fingerprint' of the material and can be calculated from 2-theta (2θ) values. The use of degrees 2θ in depicting scans is a matter of convention and related with the geometry of the material. The angle and d-spacing are related by Bragg's law as

$$n\lambda = 2d\sin\theta$$

where,

'n' is order of diffracted beam.

'λ' is the wavelength of the incident X-ray.

'd' is distance between adjacent planes of atoms. And

'θ' is angle of incidence of the X-ray beam.

The characteristic set of d-spacing generated in a typical X-ray scan provides a unique fingerprint of the material present in the sample. When this is compared with standard reference patterns and measurement of these fingerprints allows identification of the material.

1.8.3.1 Indexing Patterns of Cubic Crystals

Powder patterns of cubic substances can usually be distinguished at a glance from those of noncubic substances since noncubic substances contain many more lines. There is an almost regular sequence of lines in simple cubic and body centered cubic patterns, but the former contains almost twice as many lines, while a face centered cubic pattern is characterized by a pair of lines followed by single line and so on.

1.8.3.2 Indexing Patterns of Non-Cubic Crystals

The problem of indexing powder patterns becomes more difficult as the number of unknown parameters increases. Basically two methods are used for indexing patterns of non-cubic systems namely graphical method and Analytical method.

Analytical method involves arithmetical manipulation of the observed $\sin^2\theta$ values in an attempt to find certain relationships among them. Since each crystal system is characterized by particular relationships between $\sin^2\theta$ values, recognition of these relationships identifies the crystal system and leads to a solution of the line indices. These analytical methods are due mainly to Hesse and Lipson [48, 49 and 50].

Most of the organic crystal belongs to monoclinic systems. These crystal systems involve four and six independent constants respectively. The corresponding powder patterns are of great complexity and may contain more than hundred lines. Such patterns are seldom solved without aid of computer.

Analytical methods of indexing are search procedures designed to reveal certain numerical relationships among the observed $\sin^2\theta$ values. The digital computer is therefore a natural tool to use, and many computer programs have been written for the indexing of powder pattern. Klug and Alexander have surveyed the general problems involved and give references to specific programs.

Computer indexing is not always successful. The computer may yield not one but many sets of indices that approximately conform to the input data, it is then up to the investigators experience and judgment to select the correct set. Extraneous diffraction lines and inaccurate $\sin^2\theta$ values can mislead a computer as well as human researcher.

The powder patterns of low symmetry substances are so difficult to solve that the crystal structures of such substances are almost always determined by examining a single crystal by either the rotating-crystal method or one of its variations. With these methods the X-Ray crystallographer can determine the shape and size of an unknown unit cell.

1.9 Applications of mixed luminophors

1.9.1 Organic Light Emitting Diodes (OLEDs)

OLEDs have attracted a great deal of attention as they possess attributes that are superior to many of today's mainstream displays and illumination sources. They can emit various colors by using a wide variety of organic fluorescent or phosphorescent materials. Various green, blue and red OLEDs with high luminance efficiency, low power consumption and low operational life have been demonstrated. Recently white OLEDs have also attracted considerable attention due to their applications in the "mask less" fabrication process of large area full color displays by coupling with color filters, or

simply by using them as backlight for liquid crystal displays and paper-thin light sources. They are of high quality, low cost, flexible and superior to inorganic light emitting diodes [51, 52].

The increasing demands of highly luminescent phosphors have generated interest in basic research in the field of organic luminescence. Currently organic compounds are widely used in preparation of LEDs. Hence scientists working in the field of organic or polymeric material are paying attention to organic and polymeric LEDs. This is mainly due to its potential applications as flat, large area displays which are in demand for multimedia society. OLEDs are advantageous over their inorganic counterparts in many instances as their color can be tuned across the whole visible light in both chemical and engineering. There quantum efficiency is also increased about 4% in a polymeric LED based on PPV derivative. One of the remaining goals to be realized by using OLED is extended lifetime during both storage and operation.

Electroluminescence from OLEDs can be used as an optical probe for monitoring the processes of charge carrier injection, transport and recombination in the organic materials involved by assigning a specific role in the device operation such as injection, transport, blocking and EL emission to each individual component layer.

The doping technique is widely used for fabricating OLEDs in order to improve device characteristics of charge emission color. In OLEDs and solar cells an exciton (electron-hole pair) is generated in organic material. In OLEDs light is generated through radiative recombination of electrons and holes and it is emitted through transparent electrode. Two distinct processes, equally important govern the operation of device, charge transport and recombination. The color of emitted light is tuned by the band gap of active material that is used. In solar cells light is absorbed through the transparent electrode and the photons absorbed in the semiconductor create mobile excited electron-hole pairs. These excitons subsequently undergo dissociation yielding free electrons and holes that are collected at the contacts.

The substitution of bulky substituents on 9, 10 positions of anthracene produced a remarkable increase in quantum efficiency and the substituents control intermolecular stacking by diminishing the electroplex formation and inter and intra molecular

photochemical reactions. OLEDs composed of these anthracene derivatives show highly pure electroluminescence [53].

1.9.2 Scintillators

In the rapid development of modern photonic technology like Hg free lamp, flat panel display, CT-detector array a commercial approach was applied to accelerate search of advanced phosphors and scintillators. Phosphors are finding increasing scientific use in detecting high energy radiation and nuclear particle by converting their energy into radiations, which human eye may detect directly or indirectly through other photosensitive devices such as photomultiplier tube, photographic film. The most effective scintillating crystals are characterized by large π-electron system, high molecular symmetry, and absence of appreciable steric hindrance. Crystalline hydrocarbons are widely used. Sodium Salicylate is one of them and has highest fluorescent efficiency. It has been easily prepared and not affected by vacuum. These ideal qualities shown by Sodium Salicylate have made it most commonly used vacuum uv-radiation. Other organic crystals used as scintillators are anthracene, trans-stilbene.

Scintillators spectrometers are widely used in detection and spectroscopy of X-ray and γ-rays. Broser and Kallman discovered that γ-rays could be detected with high efficiency using a naphthalene crystal and photomultiplier [54, 55]. Common applications of scintillation spectrometers include medical imaging, nuclear and particle physics, non-destructive evaluation, nuclear non-proliferation, environmental monitoring and X-ray diffraction. There are a variety of applications that desire scintillators with high light output, good attenuation power and a low level of afterglow but absolutely require a fast scintillation decay time. Naphthalene is first organic scintillator and then anthracene was introduced as an efficient scintillator 5 times better than naphthalene [56].

1.9.3 Other commercial uses

Organic semiconductors are fascinating class of materials having wide range of properties [57].Organic sensing transistors are used in various fields such as pollution control, PH indicators, food fresheners, and toxic compounds stress and pressure indication in clothes. OLED technology is commercially used as small displays for mobile phones, car radios and digital cameras [58, 59].

White organic light emitting diodes (WOLEDs) are being considered as substitutes for conventional white light source [60]. Tang et al reported that EL devices using multilayer organic thin films show high efficiency and high brightness [4]. Organic EL devices have many advantages for flat panel displays such as; they are very thin, have high luminous efficiency and its optional color is obtainable by using fluorescent molecules throughout the entire visible region for full color display, back light for liquid color display and other illumination applications [61, 62].

Fluorescence resonance energy transfer is a useful tool to quantify molecular dynamics in biophysics, such as protein-protein interaction, protein-DNA interactions and protein conformational changes [63, 64]. For monitoring the complex formation between two molecules, one of them is labeled with an acceptor, and these fluorophore-labled molecules are mixed. When they are dissociated, the donor emission is detected upon the donor excitation. FRET is also applicable to fluorescent indicators for the ligand detection. FRET is applicable tool in study of reaction kinetics and molecular motors.

1.10 Aim and Scope of the present work

The organic semiconductors are promising materials for electroluminescence. Their great advantage seems to be the possibility of emitting all colors. The ease of purification and production of luminescence enables scientists to use organic materials extensively as a probe material in science and in technology for device applications. The polynuclear aromatic hydrocarbons (PAHs) are widely used class of organic materials. The substituted and nonsubstituted PAHs are fluorescent and known to exhibit interesting optical properties when placed in different environment. The color of emission of basic PAH can be tuned by doping it intentionally with guest. The proper selection of dopant would give doped system emitting with desired color and satisfy the demand of opto-electronic industries. The doped system of anthracene is extensively studied and it is shown that presence of dopant quenches fluorescence of anthracene and sensitization of fluorescence of dopant by excitation energy transfer. The doped anthracene crystalline powders are known to be prepared using conventional method involving the heating of the mixture of host and guest in electric furnace. Anthracene doped tetracene is the first system reported in literature.

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Literature available on doped anthracene powder indicated that structural studies and its correlation with emitting properties is not yet been reported. Similarly reports are not available on systematic structural and optical studies of anthracene doped by perylene. Earlier reports shows that the doped anthracene luminophors are prepared by heating in electric furnace which suffers from disadvantages such as charring of components, time consuming process and less photostability of doped material. It is observed that there are no reports on preparation of doped anthracene luminophors by microwave heating.

The present work- involved preparation of anthracene luminophors by doping with impurities such as tetracene, perylene, 9-vinylanthracene, 9-chloroanthracene and 9-methylanthracene and by using microwave heating. The selection of dopant is such that tetracene and perylene are planer non-substituted polynuclear aromatic hydrocarbons and solubilize in molten anthracene. Similarly vinyl and chlorosubstituted anthracene are non-planer polar molecules and solubilize in molten anthracene. It was expected that substituted and nonsubstituted dopant produce different spectral properties.

Following are the objectives of present work:

1) Preparation of luminophors of doped anthracene by Microwave heating.
2) Structural characterization by using X-ray diffraction studies to examine homogeneity and particle size of luminophors.
3) Excitation and fluorescence spectroscopy study of luminophors from the spectra recorded as a function of dopant concentration.
4) Interpretation of optical spectra on the basis of current information, optical models and available knowledge.
5) Optimizing preparation conditions to obtain luminophors emitting intensity different wavelengths in visible spectrum.
6) Studies of correlation between spectral results and electronic structure of dopant used in the present study.