

# UV\_VIS Spectrum of Sr<sup>++</sup> DOPED Alq<sub>3</sub> OLED Organic Phosphor

Sunil A. Bhagat

Kamla Nehru College, Sakkardara Square, Nagpur, 440024

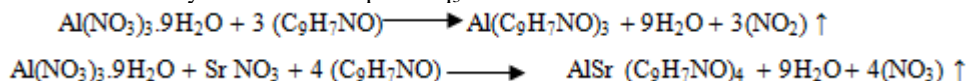
**Abstract:** Pure Sr<sup>++</sup> alkaline earth metal doped Alq<sub>3</sub> Complex was synthesized by simple precipitation method at room temperature, maintaining stoichiometric ratio. Complex was characterized by XRD and Uv\_Vis spectrum. XRD analysis reveals the polycrystalline nature of the synthesized complex. UV-vis spectrum confirms the molecular structure. The most useful region of the UV spectrum is at wavelengths longer than 200 nm. The UV spectrum of Sr<sup>++</sup> doped Alq<sub>3</sub> ranges from 200 to 400 nm and absorption of UV- visible light results in electronic transitions. Electrons are promoted from low-energy ground state orbital to higher-energy excited-state orbital. Absorption Arising from Transitions of n Electrons in compounds that contain strontium all has unshared n electrons. Thus, prepared phosphors can be a suitable candidate in ultraviolet visible region for emitting OLED, PLLCD, solid state lighting applications and ultrasonic applications.

**Keywords:** Alkaline earth elements, metal complexes Uv\_Vis spectroscopy, OLED

## 1. Introduction

Organic light emitting materials have been attracting attention of researchers from industry and academic institutions owing to their applications in OLEDs [1], stimulating interest in next-generation displays and lighting technologies [2]. The efficient and stable tri (8-hydroxyquinoline) aluminum (Alq<sub>3</sub>) is extensively investigated because of its high stability, good emission, easy synthesis, electron transport properties and high quantum efficiency. Alq<sub>3</sub> is used as electron transporting layer, as emission layer where green light emission is generated by electron hole recombination in Alq<sub>3</sub>. It is also served as host material for various dyes to tune emission color from red to green [3]. Although Alq<sub>3</sub> has low fluorescence efficiency, it has excellent properties as emitting material, namely high stable film forming, high carrier transport and good heat resistance. Tang and coworkers fabricated Alq<sub>3</sub> based multi-layer thin film electro-luminescent devices in 1987 [4, 5 and 6]. Alq<sub>3</sub> still continues to be the workhorse among the class of low molecular weight materials for OLED.

Alkaline earth metal Sr<sup>++</sup> doped play vital role in the enhancement of PL intensity with small change in PL emission wavelength. Hence it is proposed to synthesize and characterize strontium doped Alq<sub>3</sub>, which is generally used as electron transport or emission layer strontium doped Alq<sub>3</sub>



In the synthesis process, when strontium metal is added, it contributes an electron, withdrawing constituent at the 5-position in 8-hydroxyquinoline, thereby increasing the solubility of the corresponding metal quinolate complexes in non-polar solvents.

## 3. Structure

[7]. The investigation of Sr<sup>++</sup> doped Alq<sub>3</sub> is carried out by using Uv\_Vis spectroscopy.

## 2. Experimental

### Synthesis of Sr<sup>++</sup> doped Alq<sub>3</sub>

Tris(8-hydroxyquinolato)aluminum is the chemical compound with the formula Al(C<sub>9</sub>H<sub>6</sub>NO)<sub>3</sub>, widely abbreviated Alq<sub>3</sub>. 5 gm. of HQ (8-hydroxy quinoline) was dissolved in 25 ml of distilled water and 25 ml acetic acid. The solution was heated to 50°C for 30 min and filtered to remove insoluble impurities. For pure Alq<sub>3</sub>, 4.3069 gm of 3Al(NO<sub>3</sub>)<sub>3</sub> · 9H<sub>2</sub>O was dissolved in 100 ml of distilled water. This solution was heated to 50 °C for 30 min. Later the hydroxyl quinoline solution was slowly added to the above solution. Yellow precipitate was obtained. To this NH<sub>4</sub>OH<sub>4</sub> was added to get the maximum yield. The yellow precipitate was then filtered and washed with warm water until the filtered water became colorless. Finally, it was dried at 60°C for 2 hr in order to remove water molecules. The other derivative of 8-hydroxyquinoline metal complexes Alq<sub>3</sub> were synthesized by the same procedure, just by replacing aluminum nitrate by of strontium nitrate mixed in an appropriate molar ratio.

Chemical reactions of synthesis process are as follows

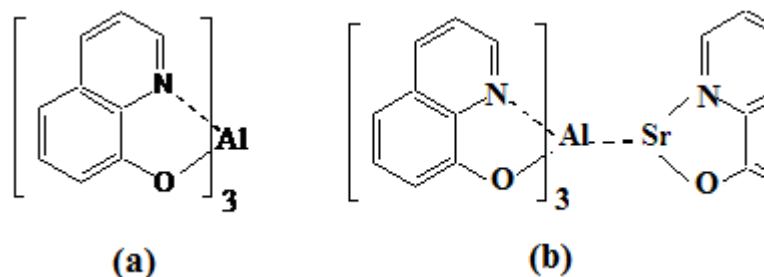


Figure 1: Structure of (a) Alq<sub>3</sub> and (b) Sr<sup>++</sup> doped Alq<sub>3</sub>

## 4. Results and Discussion

The synthesized complex has been characterized by XRD on The 'Expert pro' Automated power Diffractometer system company name "Analytical", Netherland UV-vis optical absorption taken at 'SAIF' Punjab University, Chandigarh.

### 3.1. X-ray Diffraction

X- Ray Diffractogram of  $\text{Sr}^{++}$  doped  $\text{Alq}_3$  exhibits well defined X-ray diffraction lines for the powder sample that confirm its crystalline nature. The presence of distinct lines confirmed the polycrystalline nature of the synthesized complex as shown in Fig. 2.

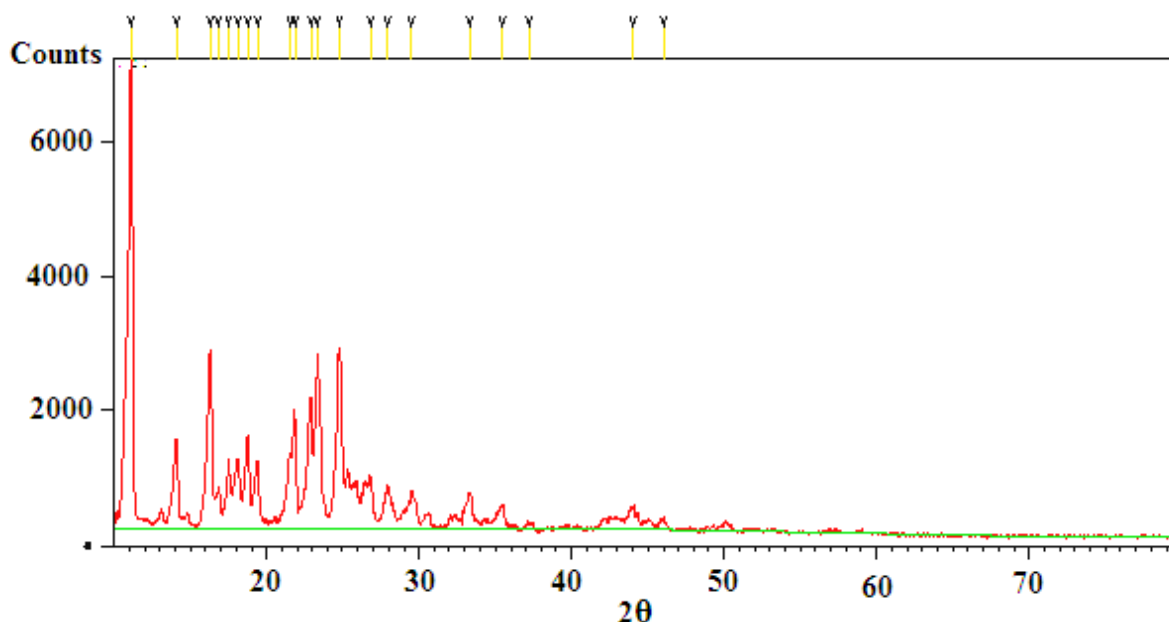
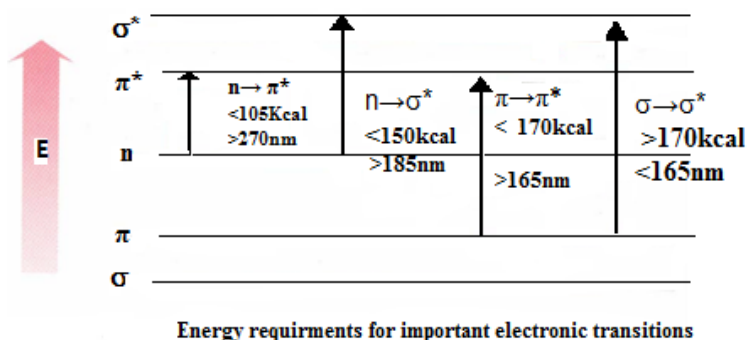


Figure 2: X-ray Diffractogram of  $\text{Sr}^{++}$  doped  $\text{Alq}_3$

### 3.2. UV \_Vis spectroscopy of $\text{Sr}^{++}$ doped $\text{Alq}_3$

In a standard UV-Vis spectrophotometer, a beam of light is split; one half of the beam (the sample beam) is directed through a transparent cell containing a solution of the compound being analyzed, and one half (the reference beam) is directed through an identical cell that does not contain the compound but contains the solvent. The wavelength of UV and visible light are substantially shorter

than the wavelength of infrared radiation. The UV spectrum ranges from 100 to 400 nm and absorption of UV- visible light results in electronic transitions, electrons are promoted from low-energy ground state orbital to higher-energy excited-state orbital. Compounds that contain nitrogen, sulfur, phosphorous, or one of the halogens all have unshared pair of electrons ( $n e^-$ ). If the structure contains no  $\pi$ -bonds, these



Energy requirments for important electronic transitions

Figure 3: Energy level diagram for electronic transitions

$n$ -electrons can undergo only  $n \rightarrow \sigma^*$  transitions. Because the  $n$  electrons are of higher energy than either  $\sigma$  or  $\pi$  electrons, less energy is required to promote an  $n$  electrons, and transitions occur at longer wavelengths than  $\sigma \rightarrow \sigma^*$  transitions as shown in fig.3. The longest wavelength absorption involves promoting one of the unshared electrons of nitrogen to an anti bonding  $\sigma^*$  orbital ( $n \rightarrow \sigma^*$ ) with a  $\lambda_{\text{max}}$  in relatively inaccessible region near 200 nm. The energies of the orbital involved in electronic transitions have fixed values, and as energy is quantized, it would be expected that absorption peaks in ultraviolet/visible spectroscopy should be sharp peaks. However this is rarely, if ever, actually observed. Instead, broad absorption peaks are seen. This is because a number of vibration energy levels are available at each electronic energy level, and transitions can occur to and from the different vibration levels, this result in peak broadening as shown in fig.4. The situation is further complicated by the fact that different rotational energy levels are also available to absorbing materials only in a few cases,

often in the vapor phase or in non-polar solvents, can fine structure be observed the vibration fine structure of the 210 nm to 270nm band and 350nm to 400nm band.

A broad absorption bands are observed in the range of 210 nm to 270nm and 340nm to 400nm causes objects to be in a UV region. The spectrum shows that the scan is from 200-400 nm. Because absorption by atmospheric carbon dioxide becomes significant below 200 nm, the 100-200 nm regions is usually not scanned unless special air-free techniques are employed. The absorption is at a maximum at 240nm and 370nm called as wavelength  $\lambda_{max}$ . The wavelength of absorption is usually reported as  $\lambda$  which represents the wavelength at the highest point of the curve. The absorbance by a compound at a particular wavelength increases with an increasing number of molecules undergoing transitions.

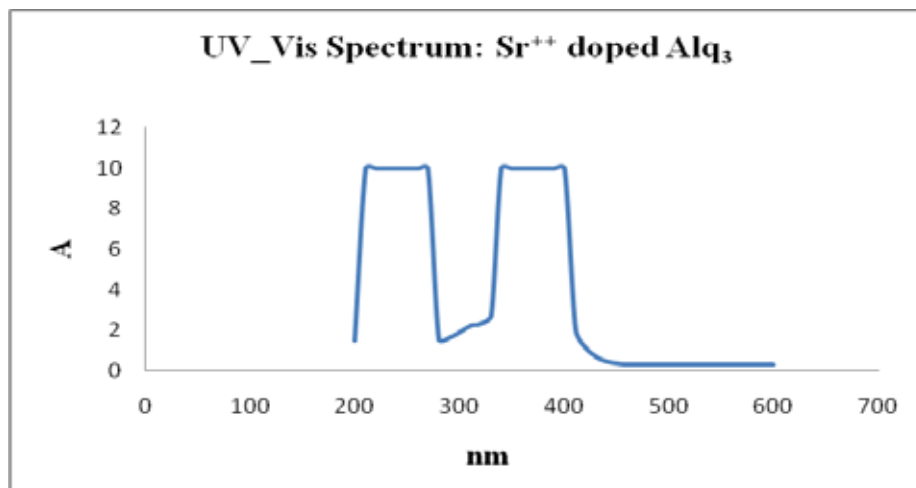


Fig. 4: UV-vis spectrum of Sr<sup>++</sup> doped Alq<sub>3</sub>

.When light is absorbed by a Sr<sup>++</sup> doped Alq<sub>3</sub> valence (outer) electrons are promoted from their normal (ground) states to higher energy (excited) states. In UV region from 210 nm to 270 nm some absorption due to  $\pi \rightarrow \pi^*$  and  $n \rightarrow \pi^*$  transition as per fig.4 (C=C, C=N). The absorption shifts towards longer wave length due to bonding between n-electron and  $\pi$ -electron ( $n \rightarrow \pi^*$ ). The intensity of color compound increases due absorption shift towards longer wavelength (deepen colour) & corresponding compound absorbed light in between 340 - 400 nm and leaving the blue and green light to be transmitted.

## 5. Conclusion

From the result, it concludes that the phosphor Sr<sup>++</sup> doped Alq<sub>3</sub> prepared by low cost conventional co-precipitation method. The most useful region of the UV spectrum is at wavelengths longer than 200 nm. The UV spectrum of Sr<sup>++</sup> doped Alq<sub>3</sub> ranges from 200 to 400 nm and absorption of UV- visible light results in electronic transitions, electrons are promoted from low-energy ground state orbital to higher-energy excited-state orbital. Although the energy absorption by a molecule is quantized, UV\_ visible spectrum consists of a spectrum of lines or sharp peaks but rather of broad absorption bands over a wide range of wavelength. The reason for the broad absorption is that the energy levels of both the ground state and the excited state of a molecule are subdivided into rotational and vibration sublevels. Since these various transitions differ slightly in energy, their wavelengths of absorption also differ slightly and give rise to the broad band observed in the spectrum. The useful transitions (200 nm-400 nm) are  $\pi \rightarrow \pi^*$  for compounds with conjugated double bonds, and some  $n \rightarrow \sigma^*$  and some  $n \rightarrow \pi^*$  transitions. Absorption arising from Transitions of n Electrons in compounds that contain potassium Sr<sup>++</sup> all has

unshared n electrons. If the structure contains no  $\pi$  bonds, these n electrons can undergo only  $n \rightarrow \sigma^*$  transitions. Because the n electrons are of higher energy than either  $\sigma$  or  $\pi$  electrons, less energy is required to promote n electrons, and transitions occur at longer wavelengths than  $\sigma \rightarrow \sigma^*$ . Thus, prepared phosphors can be a suitable candidate in ultraviolet visible region leaving the blue and green light to be transmitted for emitting OLED, PLLCD solid state lighting applications and ultrasonic applications.

## References

- [1] N.Thejo Kalyani, S.J. Dhoble and R.B. Pode., Renewable and Sustainable Energy Reviews 16 (2012) 2696– 2723
- [2] Brian W. D’Andrade, Stephen R. Forrest, White organic light-emitting devices for solid-state lighting, Adv. Mater. 16 (2004) 1585–1595.
- [3] R.Schalf, B. A. Parkinson, P.A. Lee, K. W. Nebesny, G. Jabbour, B. Kippelen, N. Peygham Barian and N.R.Armstrong, J.Appl.Phys,84,6729(1998).
- [4] Tang C, Vanslyke S, Organic electroluminescent diodes. Appl. Phys. Lett.1987; 51: 913-915.
- [5] Berleb S, Brutting W, Phys Rev Lett. 2002; 89: 286601-02.
- [6] Thejo Kalyani N, Dhoble SJ, Ahn JS, Pode RB. J Korean Phys Soc .2010; 57(4):746–51.
- [7] Bhagat SA, Raut SB, Dhoble SJ, J. of Bio. And Chem. Luminescence, Oct.2012, 27, iss.4, (wileyonlinelibrary.com) DOI 10.1002/bio.2431