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Electroluminescent characteristics of OLEDs fabricated with bis(5,7-dichloro-8-hydroxyquinolinato)zinc(II) as light emitting material

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Abstract

The zinc(II) ions interact with 5,7-dichloro-8-hydroxyquinoline to give a 1:2 (M:L) metal chelate. This chelate has a strong photoluminescence emitting maximum at 509 nm in solid state. The chelate also exhibited a bright green colored electroluminescence emitting maximum at 545 nm with good efficiency. The spectroscopic and optical characterizations of the chelate used as light emitting layer in organic light emitting devices are described.

Keywords: 5,7-dichloro-8-hydroxyquinoline; Zinc(II) complex; Electroluminescence; Emitting layer; Organic light emitting device

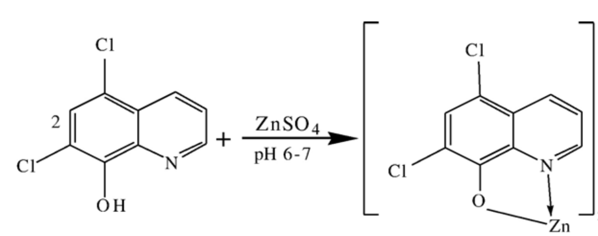
1. Introduction

Organic light emitting devices (OLEDs) are quite promising for the next generation flat panel displays [1,2]. Since Tang and Van Slyke [3] at the Eastman Kodak made bilayer thin film electroluminescent (EL) devices with two sublimed molecular layers sandwiched between the electrodes driven by a low direct current (dc) voltage to obtain a bright green emission using tris (8-hydroxyquinolinato)aluminum(III) [Alq_3] as the emitting layer, the organic electroluminescent materials and devices were studied extensively [4–9]. The metal complexes as light emitting materials had excellent properties such as low driving voltage, high efficiency, light weight, thinness, wide viewing angle and bright emission. Now, extensive research work is going on in achieving full color displays based on OLEDs [10–14]. For example, the emission color of complexes can be changed by varying the central metal ion, the number of ligands or by changing the ligand structure by introducing electron releasing or electron withdrawing groups. In this paper, we report a light emitting material that had high brightness with high efficiency based on a Zn chelate prepared with 5,7-dichloro-8-hydroxyquinoline and present its electroluminescent (EL) properties in the OLEDs which showed a green colored emission.

2. Experimental

2.1. Synthesis of metal complex

The chemicals used to synthesize the metal chelate were purchased from Fluka and were used as supplied. The chelate bis(5,7-dichloro-8-quinolinato)zinc(II) was synthesized by the method shown below



5,7-dichloro-8-hydroxyquinoline(L)

Bis-(5,7-dichloro-8-hydroxyquinolinato)zinc(II)

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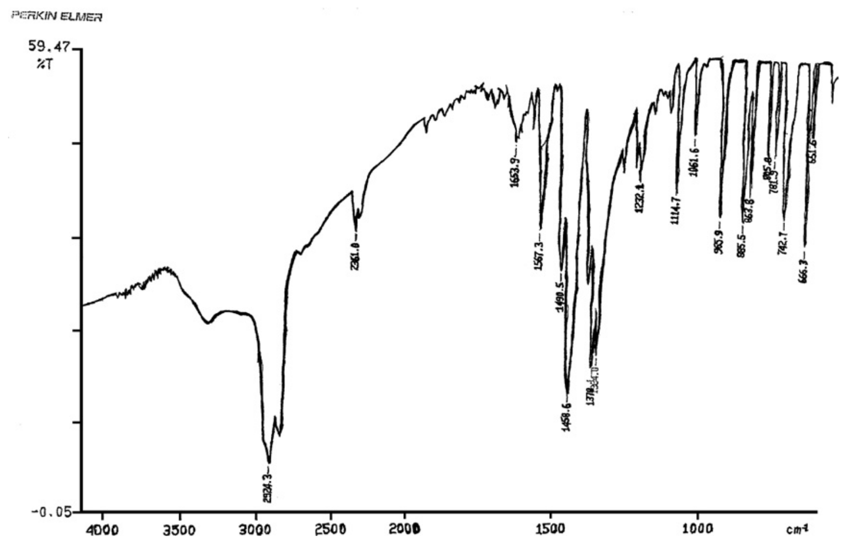

Fig. 1. IR spectra of zinc chelate in KBr pellets.

A solution of zinc sulphate (1 mmol) in water was added to a solution of the ligand (2 mmol) in ethanol and pH was adjusted to neutral. After stirring the mixture for 2 h at 60 °C on a magnetic stirrer, a crude product, which simultaneously precipitated from the solution, was collected by filtration and purified by washing with ethyl alcohol, deionised water and then again with ethyl alcohol. After filtration, the zinc chelate was dried over P_2O_5 in vacuum for 48 h to afford the dry and pure chelate of light yellow color. The chelate gave a green fluorescence light under UV light.

2.2. Instrumentation

Elemental analysis i.e. C, H, N (carbon–hydrogen–nitrogen) of the complex was done by Elemental Analyzer Perkin Elmer 2400 CHN.

Perkin Elmer 2000 FTIR was used to run the infra-red spectra of the synthesized complex in KBr pellets.

^{1}H NMR spectra were recorded on a Bruker Avance 300 spectrometer (300 MHz) dissolving the metal complex in $CDCl_3$.

The excitation and emission spectra of the complex solution in tetrahydrofuran (THF) were recorded using spectrophotometer Horiba Jobin Yvon Fluolog Model FL 3-11.

The electroluminescent (EL), photoluminescent (PL) spectra and Commission Internationale De L' Eclairage (CIE) coordinates were measured by a High-Resolution USB Fiber Optic spectrometer Model HR2000.

Current–bias voltage (*I–V*) and the luminance–current–bias voltage (*L–I–V*) were measured by a Keithley 2400 Sourcemeter and luminance meter (*L–I–V*) Model LMT RS 232 respectively.

All measurements were carried out at room temperature under ambient conditions.

2.3. Fabrication of organic EL devices (OLEDs)

To study the electroluminescence behaviour of the synthesized zinc complex as an EL material, thin film electroluminescent devices containing zinc complex were fabricated by the following method: Indium tin oxide (ITO) coated glass substrates with a sheet resistance of 15 Ω/cm^2 were cut and cleaned by ultrasonification first using a detergent solution, followed by trichloroethylene degreasing and cleaned by ultrasonification with pure isopropyl alcohol. After drying and plasma treatment with ozone, the substrates were loaded into the bell–jar deposition system for the deposition of the organics including metal

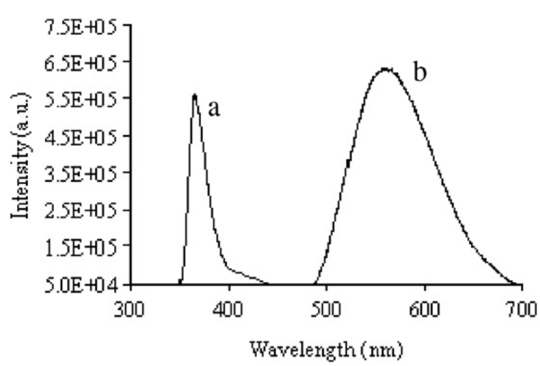

Fig. 2. Excitation (a) and emission (b) spectra of zinc chelate in THF solvent.

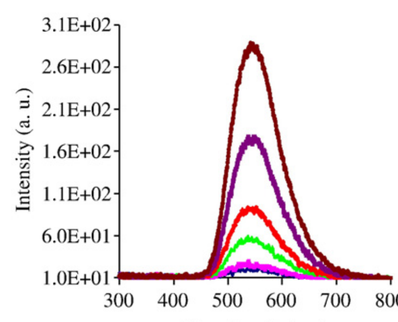

Fig. 3. EL spectra at different voltages applied on the fabricated EL device ITO/TPD/Zn chelate/Alq_3/LiF/Al.