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Short Communication

Synthesis and Characterization of a New Aluminum Complex bis (8-hydroxy quinoline) (1-10 phenanthroline) Aluminum Al (Phen)q$_2$

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A new photoluminescent aluminum complex, bis (8-hydroxy quinoline)(1-10 phenanthroline) aluminum Al(Phen)q$_2$ has been synthesized and characterized for structural, thermal and photoluminescence analysis. Structural analysis of this material was done by Fourier transformed infrared spectroscopy (FTIR). Thermal analysis of metal complex was done by thermal gravimetric analysis (TGA) and the result shows the thermal stability of this material up to 375 °C. Absorption and emission spectra of the material was measured by UV-visible spectroscopy and photoluminescence spectroscopy respectively. Solution of Al (Phen)q$_2$ in ethanol showed absorption peak at 378 nm respectively which may be attributed due to ($\pi - \pi^*$) transitions. The photoluminescence spectra of Al (Phen)q$_2$ in ethanol solution showed intense peak at 525 nm. The time resolved photoluminescence spectrum of the aluminum complex showed two life time components. The decay times of the first and second component were 5.4 ns and 21.7 ns respectively.

Keywords: Metal complex Al (Phen)q$_2$, Chemical synthesis, Photoluminescence, Thermal stability.

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1. INTRODUCTION

Organometallic complexes have attaracted much attention due to their attractive characteristics and potential application for flat panel displays ever since the Organic emitting diodes (OLEDs) reported by Tang and Van slyke by using Alq$_3$ metal complex [1-2]. OLED-based displays offer light weight devices with bright colors and low power consumption compared to liquid crystal displays. The wide viewing angle and fast response are also additional advantages for OLED based displays over the LC displays [3-6]. Organometallic complexes are used in the fabrication of organic light emitting diodes (OLEDs). Aluminium complex Alq$_3$ was the first organic metal complex used as an electron tranport layer as well as emissive layer in OLEDs [7-9]. Aluminium complexes are mostly used in the fabrication of organic light emitting diodes due to wide spectrum of the colours including blue colour, green colour obtained from different complexes in visible range hence they are used as emissive layer and electron transport layer in organic light emitting diodes(OLEDs). A lot of research is going on to fabricate new aluminum complexes [10-15]. In this work, we report the synthesis of a new aluminium complex bis (8-hydroxy quinoline)(1-10 phenanthroline) aluminum Al (Phen)q$_2$ and its optical properties(photoluminescence,UV-visible- spectra), structural properties (FTIR) and thermal stability (TGA).

2. MATERIALS AND METHODS

2.1 Synthesis of bis (8-hydroxy quinoline) (1-10 phenanthroline) Aluminium Al (Phen)q$_2$

8-hydroxyquinoline and (1-10 phenanthroline) were purchased from Sigma Aldrich. Aluminum nitrate and ethanol were purchased from Merck (Germany). Initially a solution of the ligands, 2mmol (290.32 mg) of 8-hydroxy quinoline [C_9H_7NO] and 1 mmol (180.21 mg) of 1-10 phenanthroline [$C_{12}H_8N_2$] was prepared in 60 ml of ethanol and then a solution of aluminum nitrate nonahydrate (1 mmol) (375.134 mg) in 6 ml of water was added drop wise in to solution of ligands and pH was adjusted to neutral by adding ammonia solution. After stirring the mixture for 2 h at 90 °C on a magnetic stirrer a yellowish colour precipitated was formed. The precipitate was washed with deionized water to remove the excess metal ions and then recrystallized with absolute ethanol to obtain bis[8-hydroxyquinoline] [1,10phenanthroline] aluminum. The material was dried at 90 °C in a vacuum oven. The schematic of the aluminium complex is shown in Fig. 1.

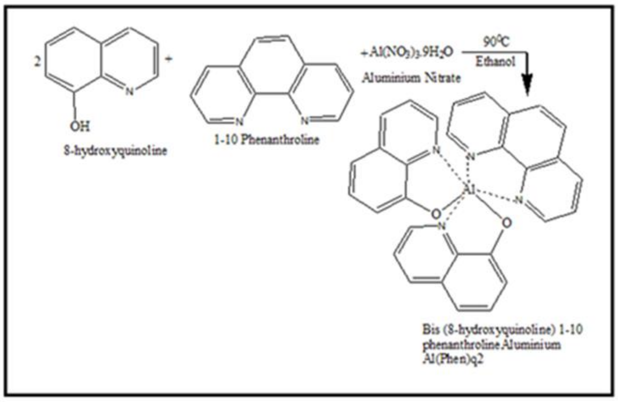

Fig. 1 – Synthesis of bis (8-hydroxy quinoline) (1-10 phenanthroline) aluminium Al (Phen)q$_2$

2.2 Instrumentation

Aluminium complex was characterized by Fourier transform infra-red spectroscopy (FTIR), thermal gravimetric analysis (TGA), UV-visible spectroscopy, photoluminescence spectroscopy and time-correlated single-photon counting (TCSPC). The infrared absorption spectrum studied using a Nicolet 5700 spectrometer. The chemical characterization of functional groups was studied by a Fourier transform infrared spectrometer in the range 1600 cm^{-1}-450 cm^{-1}. Thermo-gravimetric analysis was done by using SDTA 851Metter-Toledo-star system. TGA analysis was done in the temperature range from 20 °C to 500 °C in flowing nitrogen. The UV-visible absorption spectra of the synthesized complex were recorded on a Shimadzu UV-2401 spectrophotometer. Absorption spectra of aluminium complex were recording by UV-visible spectroscopy in the wavelength range from 300 to 700 nm. The photoluminescence spectra were recorded using a Fluorolog spectrofluorometer (Jobin yvon- Horiba model – 3-11) at room temperature. Photoluminescence spectra of the aluminium complex were recording by using photoluminescence spectroscopy in the wavelength range from 300 to 700 nm. Time-resolved PL decay spectra were recorded by a time-correlated single-photon counting (TCSPC) system from IBH (UK). Time resolved photoluminescence spectra were recorded by a time-correlated single-photon counting (TCSPC). During the experiment, the excitation wavelength and repetition rate were 341 nm and 1 mHz, respectively. The instrument response time was 800 ps.

3. RESULTS AND DISCUSSION

3.1 Structural and Thermal Characterization of Aluminium Complex bis (8-hydroxy quinoline) (1-10 phenanthroline) Aluminium Al(Phen)q2

The infrared absorption spectrum of the complex Al(phen)q_2 in KBr pellets was studied using a Nicolet 5700 spectrometer. The FTIR spectra was recorded in the range of 1600 cm^{-1} to 500 cm^{-1} as shown in Fig. 2. Bands at 1600 cm^{-1} and 1575 cm^{-1} are assigned to C=C stretching vibration involving quinoline ligand. The peaks at 1503 and 1471 cm^{-1} is assigned to skeletal vibrational stretching of the aromatic ring. The vibrations at 1383 and 1328 cm^{-1} are due to C=C/C=N stretching in the quinoline fragments of Al(Phen)q_2. Peak at 1059 cm^{-1} is characteristic of vibration of C-H group in aromatic ring located between two substituents. Peak at 969 cm^{-1} might be attributed to trans

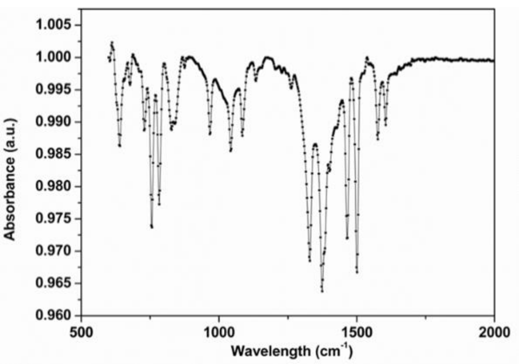

Fig. 2 – FTIR spectra of bis (8-hydroxy quinoline) (1-10 phenanthroline) aluminium Al(Phen)q_2

double bond. Peaks at 1020, 1100, 1150 and 1310 cm^{-1} are due to phenanthroline ring. Peaks at 750,787 and 824 cm^{-1} are due to quinoline group. Peak at 644 cm^{-1} is observed due to metal-nitrogen bond.

Thermo-gravimetric analysis (TGA) of aluminium complex was done in the temperature range from 20 °C to 500 °C in flowing nitrogen as seen Fig. 3. TGA result shows that aluminium complex is stable up to 375 °C.

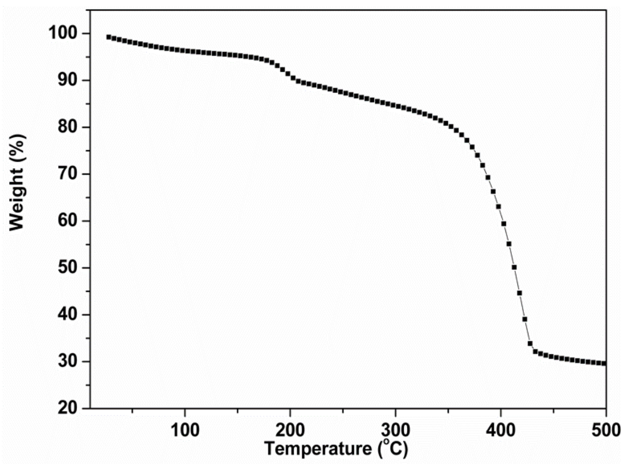

Fig. 3 – Thermo gravimetric analysis of bis (8-hydroxy quinoline) (1-10 phenanthroline) aluminium Al(Phen)q_2

3.2 Optical Properties of Aluminium Complex bis (8-hydroxy quinoline) (1-10 phenanthroline) Aluminium Al(Phen)q2

UV-visible absorption spectra were recorded on a Shimadzu UV-2401 spectrophotometer. The excitation and emission spectra of the material were recorded with a Fluorolog Spectro fluoro meter (Horiba Jobin YVON Fluolog odel FL 3-11) at room temperature. The photoluminescence and UV-visible spectra were obtained in a solution of ethanol as shown in Fig. 4. The absorption spectra of this material showed absorption maxima at 378 nm which may be attributed to the moderate energy ($\pi - \pi^*$) transitions of the aromatic rings. Photoluminescence spectra of this material showed the most intense peak at 525 nm. The intense peak of photoluminescence of this material

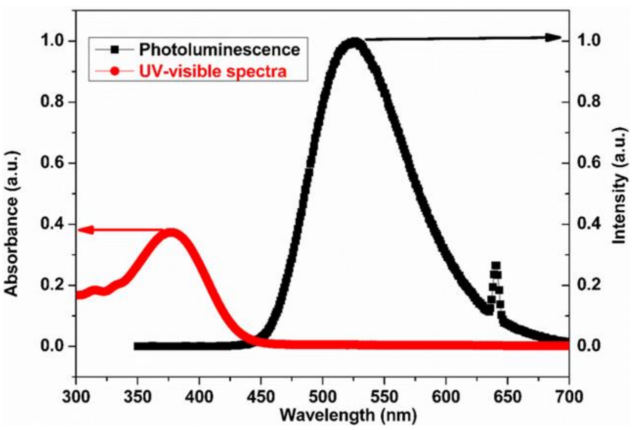

Fig. 4 – UV-visible and Photoluminescence spectra of bis (8-hydroxy quinoline)(1-10phenanthroline) aluminium Al(Phen)q_2

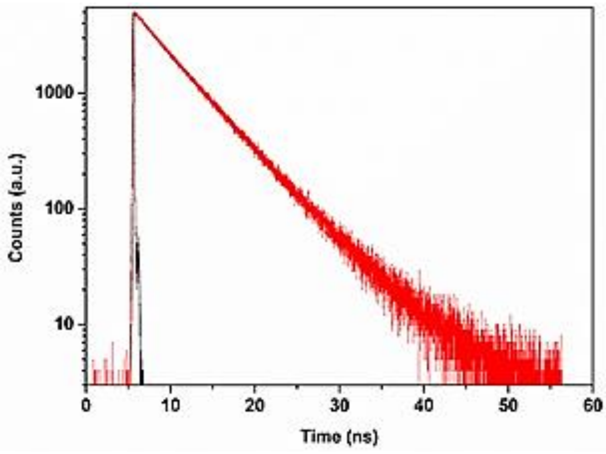

Fig. 5 – Time decay curve of bis (8-hydroxy quinoline) (1-10 phenanthroline) aluminium Al(Phen)q_2

shows emission in green region. The time resolved PL spectrum is shown in Fig. 5. Decay curve has two components.

The curve is fitted by $I = a_1 e^{-t/\tau_1} + a_2 e^{-t/\tau_2}$, where τ_1 and τ_2 are the lifetime of the components with amplitude a_1 and a_2 [16]. The decay times of the first and second component are found to be 5.4 ns and 21.7 ns respectively. The bi-exponential behaviour of the decay curve can be explained by a) a fast process which might be attributed to relaxation of the carriers into the un occupied ground state, b) the slow process can be correlated with radiative recombination from the excited state. However, both the processes contribute to the energy transfer rate which depends on the acceptor concentration [16].

4. CONCLUSIONS

Aluminium complex Al(Phen)q_2 was fabricated with the reaction of (8-hydroxyquinoline) and (1-10 phenanthroline) with aluminium nitrate. This material shows thermal stability up to 375 °C. Material Al(Phen)q_2 showed two life time components, 5.4 ns and 21.7 ns respectively. aluminium complex emits the green light in PL spectra. This material can be used as an emissive layer in organic light emitting diodes (OLEDs).

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