



## Synthesis and characterization of novel 4-(6-chloro-4-phenylquinolin-2-yl)phenolblue emitting organic phosphor

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### Abstract

A blue emitting organic phosphors of diphenylquinoline (DPQ) and its attached group were synthesized by Friedlander condensation method at 90°C for one hour and then at 140°C for four hours and then cooled for 12 hours with proper purification methods. The characterizations of crystalline materials were studied for physical and chemical parameters from absorption spectra, photoluminescence, FTIR and XRD. A UV-absorption spectrum shows maximum absorption in the spectral range 382 nm. Photoluminescence spectra were recorded in powder form at room temperature which shows excitation at 384 nm where as the emission is at 470 nm. The structural formation and its bonding nature was confirmed by FTIR spectra and it shows strongest peak of 1277.20/cm due to C-N bending vibrations. The crystallographic nature was confirmed by X-ray diffraction spectra which shows strongest peak at  $2\theta = 32.42060$  at  $d = 4.34283$  Å and  $2\theta = 21.11840$  at  $d = 4.20699$  Å. The results of polymer regarding structural conformation, thermal and optical properties shows expected results and have a great potential as blue emitters for OLED applications.

### 1. Introduction

Organic light emitting diodes (OLEDs) are electronic devices made by placing a thin film of an electroluminescent material between two conductors of different work functions. When an electrical voltage is applied, electron and hole are injected into the electroluminescent material. OLEDs bring several advantages to the product designer and developer. OLEDs are light weight, flexible, and do not require a backlight. They have a wide viewing angle, almost to 180 degrees. Benefits of OLED lighting are that it is very energy efficient, and contains no poisonous mercury. The biggest problem with OLED displays is the lifetime of the organic materials used in the LEDs. All materials age, and as the organic compounds in OLEDs age their maximum brightness drops. Blue OLED compounds are the most susceptible to aging and have a 50% drop in brightness in about 14,000 hours. This gives a display a life of 5 years of use at 8 hours a day. The drop in brightness of blue OLEDs happens much faster than red and green OLEDs which causes color balance issues as OLED displays age.

To combat this, many OLED displays drive the blue OLEDs at a higher brightness making images appear washed out in a new display [1]. Organic polymers are promising materials for use as in bendable displays, solar panels, and smart materials. [2-6]. Most of the polymers currently being developed for electronic, optoelectronic and photonic applications are based on  $\pi$ -conjugated polymers having main-chain macromolecular architectures [7]. For fabricating blue OLEDs several low molecular blue emitting materials

were used such as distyrylarylenes, metal chelates, anthracene derivatives, spirofluorenes, pyrazoloquinolines, silones, etc. Quinolines are heterocyclic compounds; Recently quinolines conjugated derivatives have generated considerable interest as blue emitting material [8, 9].

### 2. Experimental

#### 2.1 Synthesis of 4-(6-chloro-4-phenylquinolin-2-yl)

The 2 Amino 5-Chloro Benzophenone ( $C_{13}H_{11}NO$ ), (1gm), P Hydroxyacetophenone ( $C_8H_8O_2$ ) (1gm), Diphenyl phosphate 1 gm and M-cresol of 3ml were used as the starting materials for the synthesis of the polymer. The mixture of these materials are added in a round 3 neck flask and fixed the glass stirrer from the middle neck of round flask for stirring the compound. The temp of oil bath was maintained at constant temperature at 90°C for 1 hr and then at 140°C for 4 hr. After completing the heating and stirring process, the flask was taken out of the oil bath for cooling.

In the purification process, 60 ml dichloromethane (Methylene chloride) and then 60 ml NaOH solution with a 10 % NaOH concentration were added and the mixture was kept for 8 hr. Two separate layers were formed in the flask. These layers were separated by the separating funnel and then washed with 50 ml distilled water (3 times) [10]. Later, the resulting precipitate was kept in vacuum air oven at 45°C for 10 hr. for removing water contents from the synthesized complex. It is again washed with 20 ml of hexane (3 times) and again kept the sample in vacuum air oven at 40°C for 6hr. Later, the powder precipitate

was collected on butter paper, and dried at room temp for removing the moisture of the powder if any left. Finally, light yellowish colour powder with compound weight 1.60gm

was obtained. The scheme for the synthesis of 4-(6-chloro-4-phenylquinolin-2-yl) shown in Fig.1.

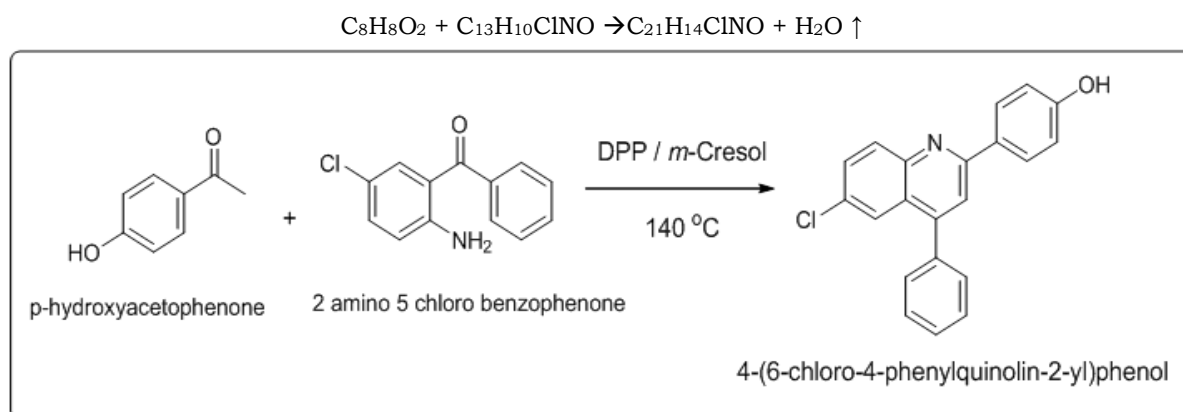


Fig. 1

### 3. Characterizations

Physical and chemical properties of the synthesized 4-(6-chloro-4-phenylquinolin-2-yl)phenol phosphor were characterized by photoluminescence (PL) spectra on RF5301 Spectrofluorometer, Fourier Transform Infrared (FTIR) spectra on Bruker, UV-visible spectra on Perkin Elmer LAMBDA 35 and X-ray diffraction on X-ray Diffractometer System XPERT-PRO (PAN analytical) [11,12].

### 3.1 Photoluminescence Spectra (PL): -

When 4-(6-chloro-4-phenylquinolin-2-yl)phenol in powder form is excited at 384nm and it shows emission in 470nm as shown in Fig.2 (a) and 2 (b), respectively. Thus this polymeric compound shows bright emission in blue region. And if we see the absorbance spectra of the material it also shows a very broad absorbance band in 330 nm to 420nm region.

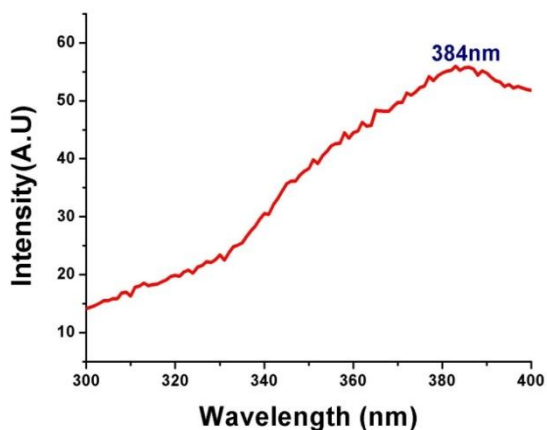


Fig. 2 (a)

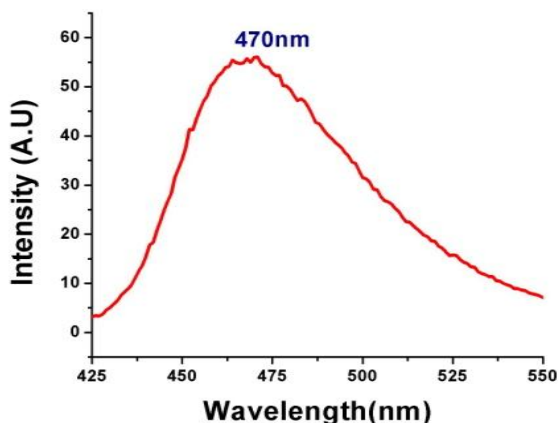


Fig. 2 (b)

### 3.2.UV-visible spectra: -

In organic compound various sorts of orbits are present. When light passes through the compound, energy from the light is used to promote an electron from a bonding ( $\sigma$  or  $\pi$ ) or non-bonding ( $n$ ) orbit into the empty anti-bonding orbitals ( $\pi^*$  or  $\sigma^*$ ). In 4-(6-chloro-4-phenylquinolin-2-yl)phenol when an electromagnetic radiation is passed in the ultraviolet region and visible region with multiple bonds a portion of the radiation is

normally absorbed by the compound. The amount of absorption depends on the structure of the compound and wavelength of the radiation. Because of  $\pi$  to  $\pi^*$  and  $n$  to  $\pi^*$  transition. The UV-visible absorption spectra of 4-(4-phenylquinolin-2-yl)phenol shows strong absorption peak at 382nm as shown in fig. 3. The UV-vis absorption spectra could provide a good deal of information on the electronic structures of the polymeric compound.

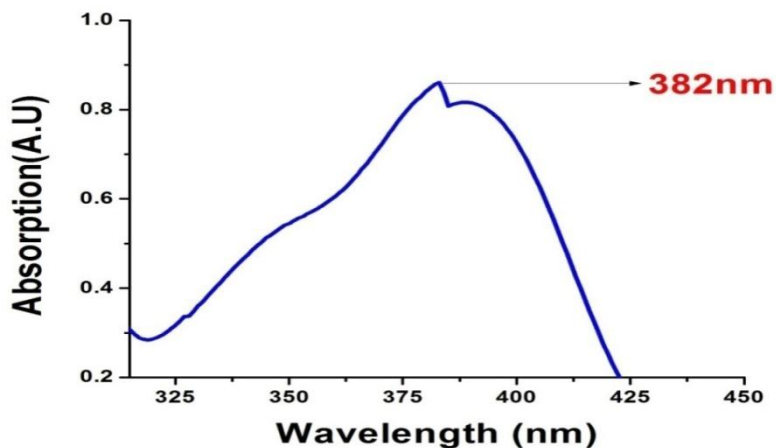


Fig. 3

### 3.3 FT-IR spectra:-

Fourier Transform Infrared Spectroscopy (FTIR) offers quantitative and qualitative analysis for organic and inorganic samples along with the identification of chemical bonds in a molecule by producing an infrared absorption spectrum. FTIR is an effective analytical instrument for detecting functional groups and characterizing covalent bonding information. The molecular confirmations of polymeric compound are done by FTIR spectra. In the complex 4-(6-chloro-4-phenylquinolin-2-yl)phenol show in the fig.4 we

get some sharp peaks at  $695.54\text{cm}^{-1}$ ,  $774.97\text{cm}^{-1}$ , and  $826.97\text{cm}^{-1}$  which shows a presence of C-Cl stretch due to alkyl halides group. There are aromatic amines strong C-N stretch bands for Carbon-Nitrogen bonds in an aromatic ring at  $1277.20\text{cm}^{-1}$ . Due to medium Carbon-Carbon(C-C) bond stretch in aromatics ring we get peaks at  $1477.67\text{cm}^{-1}$ ,  $1586.57\text{cm}^{-1}$  and The broad peaks at  $3042.28\text{cm}^{-1}$  and  $3255.23\text{cm}^{-1}$  shows O-H (Oxygen- Hydrogen) stretch.

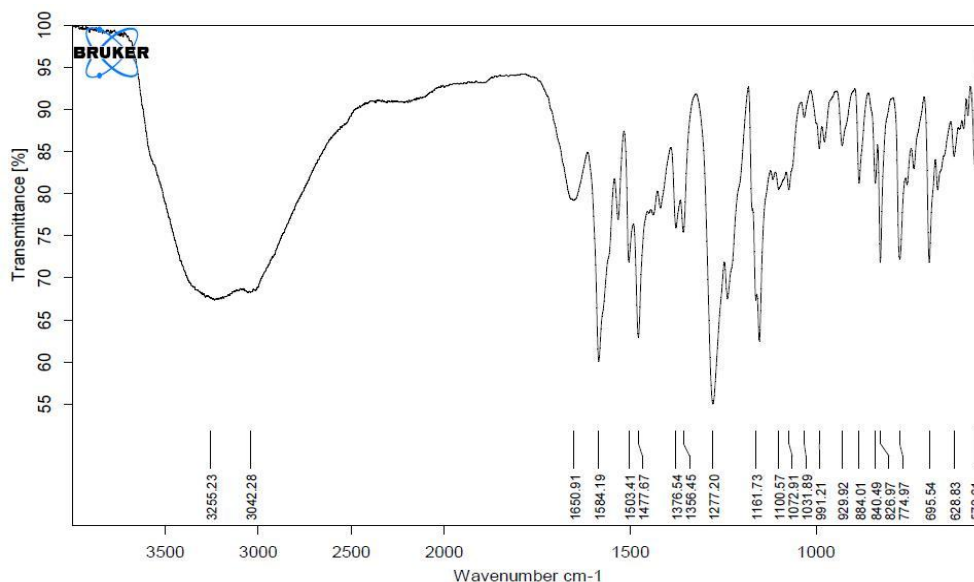


Fig. 4

### 3.3.XRD spectra :-

We understand the structural information of the sample from XRD spectra. The CuK $\alpha$  radiation ( $\lambda = 1.54060\text{\AA}$ ) operated at 30mA and 40KV. The X-ray diffraction analysis of powder 4-(6-chloro-4-phenylquinolin-2-yl)phenol is shown in fig. 5 shows sharp,

strong diffraction peaks. With relative intensity 87% was observed at  $2\theta$  value  $32.4206^\circ$  and interplaner distance  $4.34283\text{\AA}$  and second at  $2\theta$  value of  $21.1184^\circ$  where the relative intensity is 100% and interplaner distance is  $4.20699\text{\AA}$ .

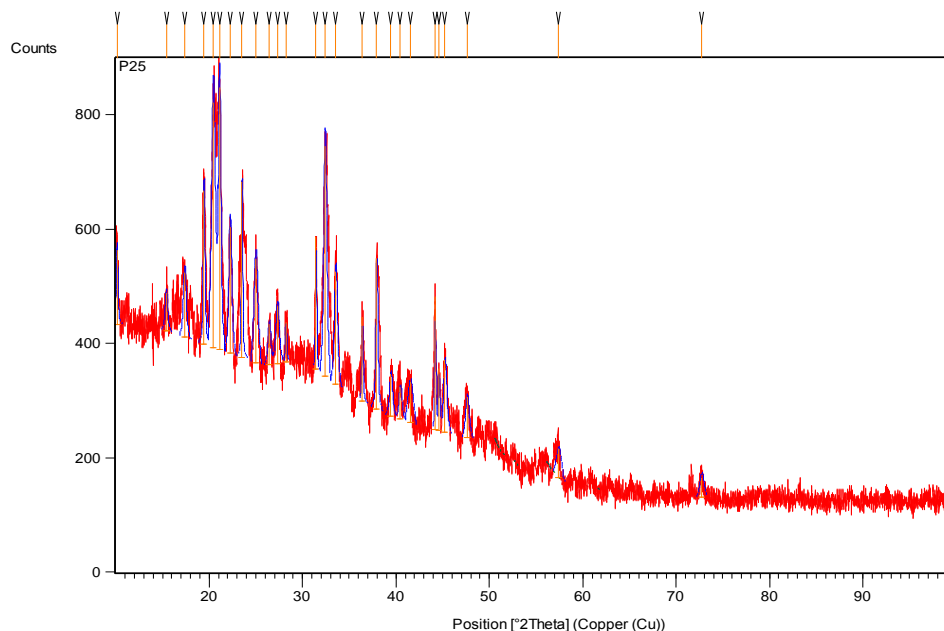


Fig. 5

### 3. Conclusions :-

An organic phosphor 4-(6-chloro-4-phenylquinolin-2-yl)phenol, belonging to DPQ family was synthesised by Friedlander condensation reaction. The synthesised phosphor was soluble in acetic as well as basic radicals. The crystalline powder of the phosphor does not show any emission but it shows blue color emission in the solvents under UV source. The absorbance spectrum shows broad band where the highest absorption is 382 nm. The PL spectrum shows the strong excitation at 384 nm whereas the emission is obtained at 470 nm, which lie in the blue region of the electromagnetic spectrum.

The FTIR spectra of 4-(6-chloro-4-phenylquinolin-2-yl)phenol show the sharp peak at 1277.20/cm due to C-N stretching and peaks at 1477.67cm<sup>-1</sup>, 1586.57cm<sup>-1</sup> due to C-C bending vibrations and Peaks at 3042.28cm<sup>-1</sup> and 3255.23cm<sup>-1</sup> shows O-H (Oxygen-Hydrogen) stretch. Many well resolved peaks were obtained in XRD pattern of the sample. The presence of such large distinct peaks confirms the crystalline behaviour of the synthesized complex. This confirmed the polymer 4-(6-chloro-4-phenylquinolin-2-yl)phenol as a group of DPQ family and it can be used as a blue light emitting organic phosphor for organic light emitting diodes (OLEDs) and solid state lighting.

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