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Synthesis of Organic Phosphor Materials for Display Devices

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Abstract: *An organic light emitting diode (OLED) also known as organic electroluminescent diode is a display device like light emitting diode in which an emissive electroluminescent layer is a film of organic compound material that emits light in response to an electric current. This organic layer is situated in between two electrodes; typically at least one of these electrodes is transparent. The organic molecules have conductivity levels ranging from insulators to conductors, and are therefore considered as organic semiconductors. Organic semiconductors were synthesised byone of the method known as the method of Friedlander condensation reaction. Originally, the basic polymer synthesised organic material is group of Diphenylquinoline (DPQ) family which consisted of a single organic layer for OLED. The family members of DPQ were synthesised by bonding chlorine- methyl, bromine, methyl, methoxy, P- hydroxyl, P-Acetyl-biphenyl and P- Acetyl bi-chlorine to the original structure of DPQ at various positions. All the synthesised polymers show crystalline in nature and emits blue colour under UV in various acidic as well as basic solvents like acidic acid, formic acid, chloroform, dichloromethane, tetrahydrofuran etc. The synthesised phosphors were characterised by different techniques to study physical, optical and chemical properties such as Fourier Transform infra-red (FTIR), UV- Visible absorption and photoluminescence spectra, X-Ray diffraction spectra (X-RD), Thermo gravimetric analysis (TGA) and Differential thermal analysis (DTA). All The blue emitting organic phosphors has generated considerable interest owing to their good photoluminescence efficiencies.*

Keywords: OLED's, Solid State Lighting, Friedlander Condensation Reaction, Organic Phosphors.

I. Introduction

Organic light emitting diodes (OLEDs) have gained considerable attention in the last two decades. The field of organic and polymeric light emitting diodes (PLEDs) has progressed rapidly since the initial reports by Tang and VanSlyke and Burroughes et al [1, 2]. Although researcher are trying to improve the quantum efficiency of both photoluminescence (PL) and electroluminescence (EL) OLEDs, the challenges still remain[3].Commonly, the blends of three primary (red, green and blue) or complementary colours (yellow and orange) entail white emission. Among all, the luminous efficiency of blue OLEDs still needs to be improved [4].

Hence it's an urgent task to design novel blue light emission materials which matches with their counterpart with respect to luminous efficiency, lifetime so as to design a stable white emission from them.In this regards, organic phosphors based on quinoline constitute an important class of heterocyclic group and thus generated considerable interest among the researchers globally. Poly (quinoline) swas first reported in the 1970s by Stille and co-workers [5] by employing Frielander condensation as a polymerization step, in order to increase the demands for thermally stable and mechanically strong polymers.

The characteristic features make them interesting for electronic and/or electro-optical devices. Prior state of art revels that the researchers have extensively investigated the optical and electronic properties of poly (quinoline) s including photo-conductivity [6], optical nonlinearity [7-10], photoluminescence [11-13],electroluminescence [14-17], Charge transfer [18] and electron transporting properties [19] for their potential applications in OLEDs, organic photovoltaic devices [20].

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II. Synthesis Process

Organic semiconductors were synthesised by the method of Friedlander condensation reaction [21]. The DPQ polymer and their family members were synthesised by taking proper chemical compositions in a three neck flask placed in a oil bath maintained at 90 ^{0}C for one hour and then at 140^{0} C for four hours as shown in figure- 1.The materials and the chemicals used for the synthesis of DPQ family are 2-Amino,5 Cholorobenzophenon, P- methyl Acetophenon, Diphenyl phosphate, m- Cresol, Amino benzophenon, Dicholoromethane, 10% NaOH solution, acetic acid, formic acid, $MgSO_4$, methyl chloride, Hexane, etc. All the chemicals are 99 % pure and of AR Grade. The reaction mixture was purged with an Argon atmosphere (Purity- 99.99%).

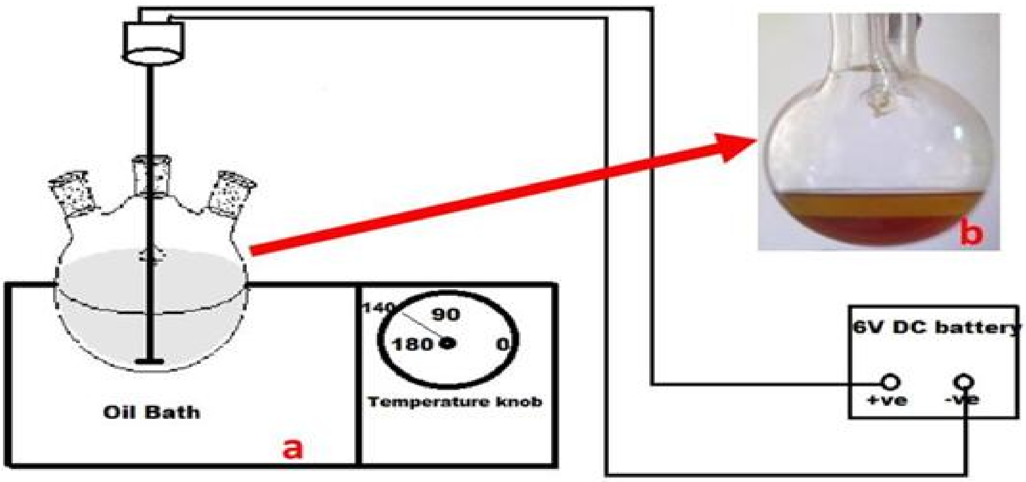

Figure: 1- Synthesis process

After completing the heating and stirring process, the flask was taken out of the oil bath for cooling up to eight hours. Organic samples were purified by proper method to get yellowish organic powder. All the derivatives of DPQ couldn't emit light but they are tested for the emission of light in various solvents and they emit blue light under UV source. The structure of synthesised organic material Diphenylquinoline (DPQ) is shown in figure-2.

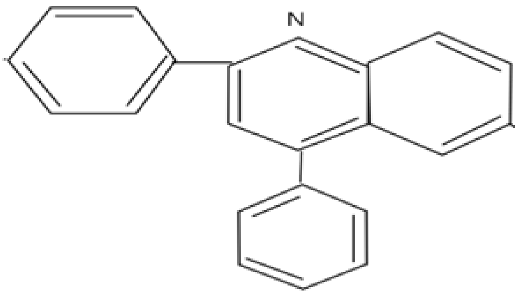

Figure 2: Chemical structure of DPQ

The synthesised derivatives of DPQ obtained by above mentioned method are chlorine – methyl- Diphenylquinoline, bromine-Diphenylquinoline, methyl-Diphenylquinoline, methoxy-Diphenylquinoline, P-hydroxyl-Diphenylquinoline, P-Acetyl-biphenyl-Diphenylquinoline and P- Acetyl bi-chlorine-Diphenylquinoline.

III. Characterizations

Physical, chemical and optical properties of the synthesized organic phosphor were studied using X-ray diffraction (XRD), Thermogravi metric and differential thermal analysis (TGA/DTA), Fourier Transform Infrared (FTIR) and photoluminescence (PL) spectra. Well resolved distinct peaks in the XRD pattern of the sample confirm its crystalline nature. The TGA curve infers that the complex maintains its properties with greater stability. DTA curve displays sharp

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melting point of the samples. FTIR spectra of all the organic derivatives shows proper peaks showing the element attached to the original structure of DPQ with type of bonding. The PL spectrum illustrates strong excitation and emission in the visible range showing blue colour wavelength in the range 365 -460 nm, which lie in the blue region of the electromagnetic spectrum. Figure -3 shows some of the characterization of the organic samples.

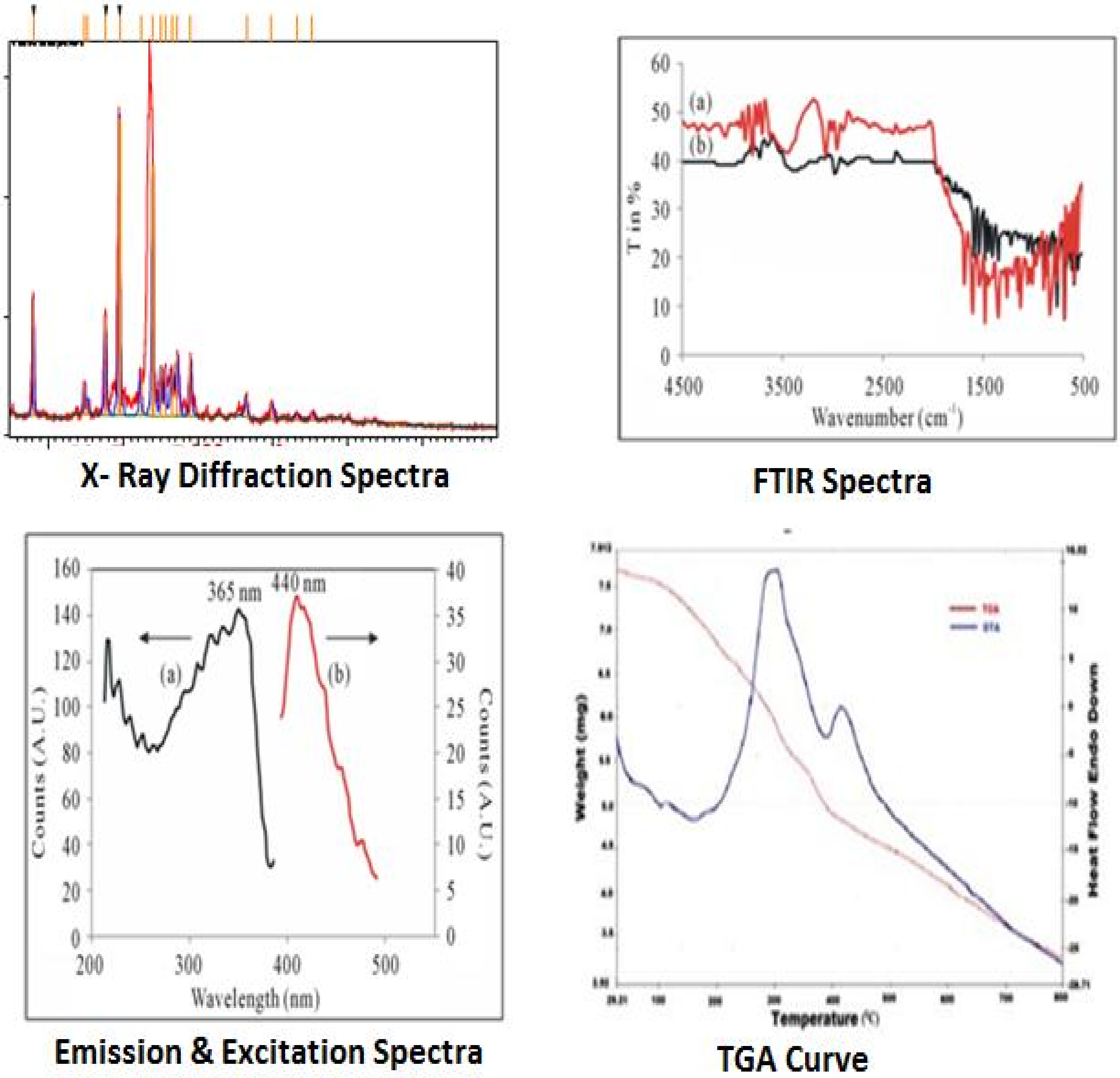

Figure 3: Characterization of organic samples

IV. RESULT AND CONCLUSION

We have synthesised organic phosphor material DPQ and its derivative by attaching various compounds at different positions to the original structure of DPQ. All the organic compounds show good thermal stability, sharp melting point in the curve, crystalline in nature. The elements present in the sample was also confirmed from FTIR spectra and shows peaks as per the bonding of the elements. The UV- vis absorption spectra could provide a good deal of information on the electronic structure of the polymeric compound with very strong emission in the BLUE range 440 to 460nm.All the samples emits blue colour under UV in various solvents. These results reflect that the synthesised organic phosphor materials can be used as tenable emissive materials in the visible range of blue colour emission in the fabrication of solid state devices and flat panel display.

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