

Preparation and Characterization of Copolymer of Benzene and Perylene Photoluminescence Organic Material

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Abstract: OLED organic light emitting diode intended primarily as picture elements in practical display devices. In the present study an organic material which is a copolymer of benzene and Perylene was synthesised and characterized by Electroluminescence spectra (EL), Current Voltage (I-V), UV-Vis absorption spectra and Thermogravimetric Analysis (TGA). The result of device characterized by ITO/BPery /Al layered diode, layered was found highly effective for application of this as electroluminescence material.

Key words: Electroluminescence material, OLED , TGA and benzene- perylene copolymer

INTRODUCTION

An organic Light-Emitting Diode (OLED) is a thin-film Light-Emitting Diode (LED) in which the emissive layer is an organic compound. OLED technology is intended primarily as picture elements in practical display devices. These devices promise to be much less costly to fabricate than traditional LCD displays. When the emissive electroluminescent layer is polymeric, varying amounts of OLEDs can be deposited in rows and columns on a screen using simple "printing" methods to create a graphical colour display, for use as television screens, computer displays, portable system screens, and in advertising and information board applications. OLED may also be used in lighting devices. OLEDs are available as distributed sources while the inorganic LEDs are point sources of light

Goldfinger (1949) obtained a benzene-soluble polymer by using Wurtz-Fittig reaction. The Ullmann reaction was also attempted for the synthesis of high molecular weight all para-linked PPPs (Claesson *et al.*, 1951). The Ullmann reaction was found suitable for the polymerization of substituted phenylenes such as *methy* (Kern *et al.*, 1950), *nitro* (Wirth and Mullar, 1964) and *perfluorophenylene* (Hellmann *et al.*, 1955). The Grignard method of polymerization has also been used in the preparation of both meta-linked and substituted poly *p-phenylenes* (Taylor *et al.*, 1981; Kern *et al.*, 1955). This reaction usually yields higher molecular weight polymers than those obtained by the Wurtz-Fittig method (Kern *et al.*, 1955) but appear less efficient than the Ullmann synthesis. In the present work an attempt was made to develop a photoluminescent organic material from copolymerisation of Benzene and Perylene, which is cost effective, as well as show better performance.

The more efficient synthetic route to prepare copolymer of benzene and perylene was also done by Yamamoto *et al.* (1975) and Yamamoto and Asagi (1978) in late 1970s also.

MATERIALS AND METHODS

The study was conducted in 2005-2006 at A.I.J.H.M.College, Rohtak

Synthesis of Co-Polymer of Benzene and Perylene (BPery): 156 g of Benzene is mixed with 0.50464 g of Perylene in a 1000 mL capacity beaker with the help of mechanical stirrer when Perylene completely dissolve in Benzene, Kovacic mixture (Mixture of 133.34 g AlCl_3 and 134.48 g of CuCl_2) was added to mixture of Benzene and perylene with continuous stirring and the mixture was stirred with the help of mechanical stirrer for 60 min. The addition of Kovacic mixture to the solution give intense fumes of HCl comes out and the color of the mixture turns dark blue. The stirring was continued for about 4 h. The reaction mixture started turning green with the polymerization and viscosity increases with polymerization. The polymer synthesized by above method was washed with warm solution of water and HCl (1:1) till it gave a transparent filtrate. The copolymer was washed again with warm distilled water to remove excess HCl.

The copolymer was then dried at about 60-70°C till it became Brown in color. The polymer was purified by refluxing in benzene for the 24 h at 90°C and solution was then filtered by Whatman filter paper No.4 Yellow color solution obtained which give green fluorescence under the UV lamp and the red brown polymer. The polymer was taken and the process of refluxing the polymer was repeated with Benzene to give pure polymer. The refluxed

polymer is then refluxed with chloroform for 24 h at 80°C. The refluxed polymer is then filtered with Whatman filter paper no.4 and a dark yellow color solution obtained which give green fluorescence after dilution under the UV lamp and the red brown polymer. On further reflux no color solution obtained

A mono-layered light emitting diode was fabricated using Copolymer of benzene and perylene as emitting layer. The device was fabricated on a Patterned Indium Tin Oxide (ITO) coated glass substrate having a sheet resistance of 15 ohms². The substrate was cleaned in an ultrasonic bath using neutral labogent solution, distilled water, acetone, trichloroethylene and then with isopropyl alcohol. The copolymer was deposited on the glass substrate having a layer of ITO by vacuum deposition machine at below 200°C and a pressure of 10⁻⁴ to 10⁻⁵ bar. The thickness of the copolymer layer was 200-400 nm. The aluminium was deposited by the vacuum deposition the thickness was 200-300 nm as cathode using the shadow mask.

RESULTS AND DISCUSSION

Copolymer of benzene and perylene (Bpery):

UV-VIS absorption spectra of copolymer of benzene and perylene: UV-VIS Spectra of the Copolymer of benzene and perylene was recorded on a Shimadzu UV-2401 Spectrophotometer. The sample was prepared in chloroform of the fraction of the reflux Ist and IInd. In the Ist fraction absorption peak was observed centred at 455, 366 and 286 nm as shown in Fig. 1. The absorption peak in the fraction IInd was also similar.

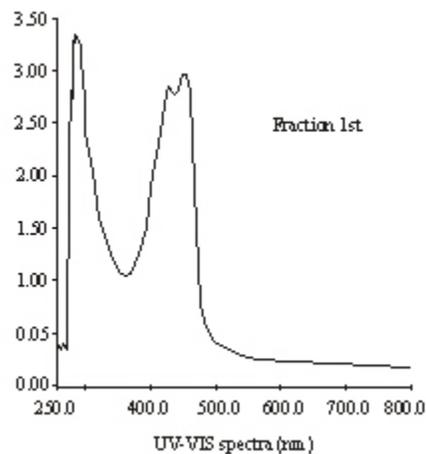
The absorption peaks of the polymer was obtained at the 454, 429 and 280 nm in Fig. 1.

Thermogravimetric analysis (TGA) of co-polymer of benzene and perylene:

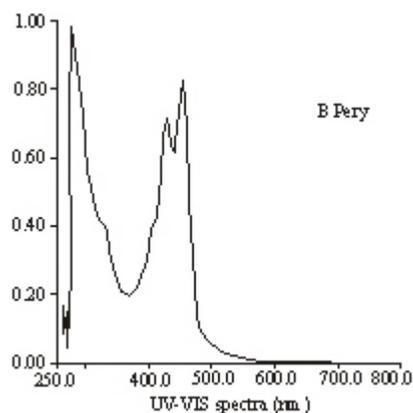
The Thermogravimetric Analysis (TGA) of the Co-polymer of Benzene and perylene was carried out on Mettler Toledo Star System and shown in Fig. 2. The TGA plot of the material shows loss in mass started at 300°C due to the degradation of the polymer chain. The degradation of the polymer continues up to 680°C. The total lose in the mass was 22.8498%. Here initially 4.6941 mg of sample is taken. The graph shows that the sample starts degradation at 300 °C. This shows that the sample is stable up to 300°C.

Electroluminescence (EL) spectra of co-polymer of Benzene and perylene:

The electroluminescent (EL) spectrum of the single-layer ITO\Bpery\AL device was recorded applying a potential of 15 V across it. The photoluminescence maximum for copolymer (Bpery) occurs at 602 nm, and the electroluminescence emission maximum is found blue shifted and occurs at 578 nm as shown in Fig. 3, and results in orange-red emission from



(A)



(B)

Fig. 1: UV-VIS spectra of the copolymer Benzene and perylene

Absorption peaks of fractions	Absorption peaks of Polymer
455 nm	454 nm
366 nm	429 nm
286 nm	280 nm

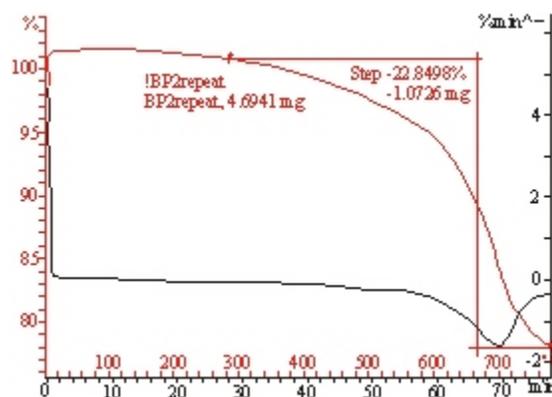


Fig. 2: TGA graph of copolymer of Benzene and Perylene

the device. It was observed that the EL emission maximum was not dependent on the applied voltage and

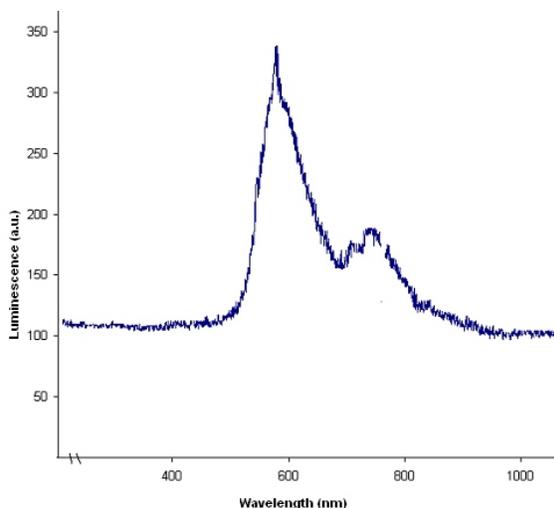


Fig. 3: Electroluminescence Spectra of ITO/BPery/Al diode

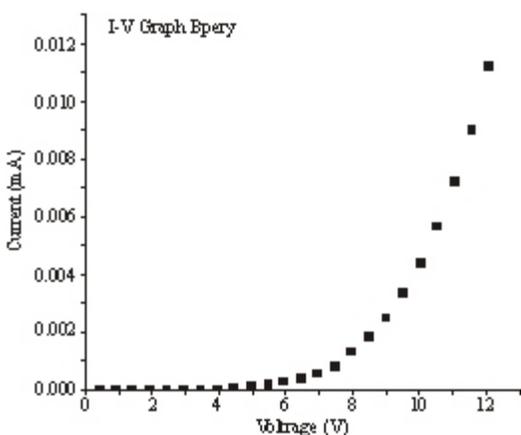


Fig. 4: I-V Graph of the Copolymer of Benzene and Perylene

Table 1: Observation Table For I-V Graph of the Copolymer of Benzene and Perylene

Current	Voltage	Observation
0.0001	4 V	Emission start at 4V and produces
0.0005	6 V	Red color at 11V
0.0015	8 V	
0.0045	10 V	
0.0075	11 V	

stayed fixed at 578 nm. Therefore the material could be used for orange red emitting device.

I-V Characterisation of copolymer of Benzene and Perylene: The current voltage (I-V) characteristics of the fabricated device were recorded by applying a DC voltage across the device with ITO as positive electrode and the aluminium as negative electrode (forward bias) as shown in Fig. 4. The current voltage (I-V) characteristics show that the current start rising above 4V indicates the onset of light emission (threshold voltage). The I-V characteristics of the device show highly non-linear nature with ohmic conduction at low voltage and trap limited

conduction at high voltage. An intense Red emission was observed from the device on applying a voltage of 11 V across it (Table 1).

CONCLUSION

Copolymer of Benzene and Perylene (Bperylene), were synthesised by Kovacic method and polymers were characterized by taking UV-VIS Absorption Spectra, Fourier Transform Infra Red Spectra, Photoluminescence (PL) Spectra and Thermo-Gravimetric Analysis (TGA).

The results of UV-VIS Absorption Spectra and Photoluminescence (PL) Spectra of these materials show that materials synthesised were of good purity.

According to the Thermo-Gravimetric Analysis (TGA) of polymers, the thermal stability of the polymers was found up to 300°C which is enough for the OLEDs.

The device of the following configurations ITO/Bperylene/Al, was fabricated and there Electroluminescence (EL) spectra and Current Voltage (I -V) characteristics were measured.

From the Electroluminescence (EL) spectra and Current Voltage (I -V) studies of the devices, it is clear that the device with configuration ITO/Bperylene/Al require comparatively Voltage nearly 15 V for the functions and produced light Orange-red Electroluminescent. The photoluminescent spectra show at 500 nm. The electroluminescence may be improved by using the electron injecting layers.

The material synthesised have shown a very good results in application of OLEDs. Therefore, the synthesised materials have good prospects for the Industrial applications as electroluminescent materials in coming days.

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