PREPARATION OF POLYMER LIGHT-EMITTING DIODES FROM POLY(2-DECYLOXY-1,4-PHENYLENE)

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Introduction

Conjugated Polymers offer many advantages as materials for use in light-emitting diodes in terms of relatively stable and easy fabricated materials.

Among the blue emitting materials, Poly(paraphenylene)(PPP) and its derivatives are promising because of their high photoluminescence(PL) efficiency.

Y.Yang et al. reported the serious solubility problem associated with stiff, rigid chain polymer, such as PPP can be tackled easily by attachment of unbranched alkoxy groups per repeating unit[1]. They have confirmationally rigid backbones, constructed from planar π -system, and flexible alkoxy side chains which render them soluble and hence processable, such materials may be transformable, in favorable cases, to the unsubstitued PPP by thermal cleavage of the pendant chains.[2]

Our investigations are focus on the characterization, optimal condition of blue LED made from single-layer device of poly(2-decyloxy-1,4-phenylene).

Results and Discussion

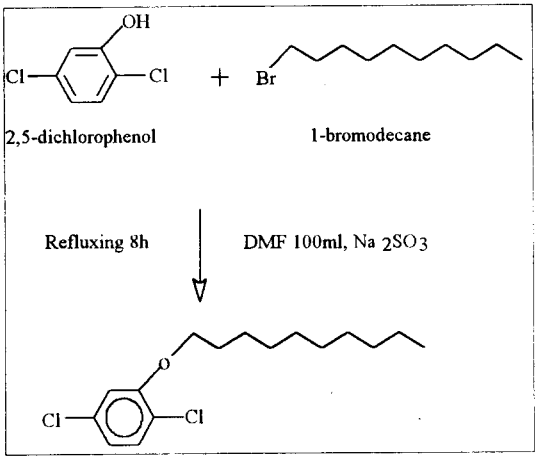
Monomer Synthesis : 2,5-Dichloro-1-decyloxybenzene

2,5-dichlorophenol, 1-bromodecane, sodium carbonate, and DMF was refluxed for 8h at 120℃. The solution was then cooled and filtered. The combined filtrate was dissolved in ether and washed with water, 5% NaOH aqueous solutions, and water, and dried over Mg_2SO_4. The residue was twice recrystallized from ethanol and dried in vacuum NMR, GC-MS indicated a purity.

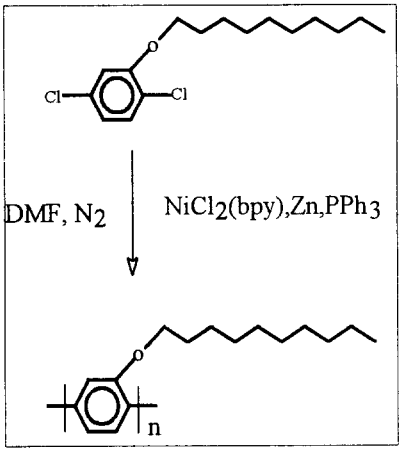
Polymer Synthesis : Poly(2-decyloxy-1,4-phenylene) (DO-PPP)

2,5-dichloro-1-decyloxybenzene (36.5 mol), triphenylphosphine (20 mmol) , zinc dust (120.6 mmol), dipyridyl (1.70 mmol) and nickel chloride (1.70 mmol) were charged into a 250 ml flask and purged with nitrogen. DMF was added, and the mixture was stirred at 85℃ for 50h. The mixture was cooled and poured into 200 ml methanol. 30ml of concentrated HCl was added, and the mixture was stirred overnight to effect a sticky mass.

The washing procedure was done according to the method of Rehahn et al.[2]



a) Monomer Synthesis



b) Polymer synthesis

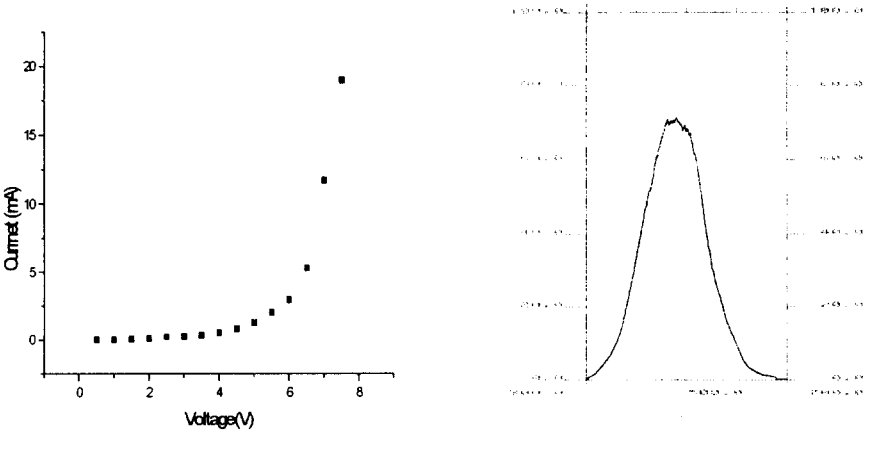
Device Fabrication

Substrate used were ITO-coated glass with a sheet resistance of less than 50Ω/square. The ITO-coated glass substrate were etched and patterned to serve as the anodes, Al was used as the cathode.

Because the surfaces of the ITO substrates are very important to polymer LED's, they carefully cleaned before use. The luminescent layer was spin cast from THF solution.The contact of aluminium was vaccum deposited.

Single-layer ITO/DO-PPP/Al device were somtimes unstable during the measurement due to leakage current. This is an indication of pinholes in the polymer film. This problem is mostly due to the low molecular weight of the synthesized DO-PPP. Spin coated films show small crystalline structure under cross-polarized microscope.

Fig.1(a) shows the typical I-V characteristic for the fabricated devices. When the applied voltage increases , the current increase superlinearly near turn-on voltage. It is just as the I-V characteristics of other organic LEDs



(a) (b)

Fig1. (a) I-V characteristic and (b) EL of ITO/DO-PPP/Al device

Fig.1(b) shows the electroluminescence spectrum obtained from the device. at 10.5V.

The device operating voltage was too high, about 10V. DO-PPP showed a low current , ~ 6 mA at 7V and a short life time. This is probably due to the contaminant in the polymer. In general , the contaminant in the polymers will quench the fluorescence of the polymer materials and impair the performances of the polymer LEDs.[3]

Despite these problems, sigle-layer ITO/DO-PPP/Al showed relatively bright blue light.

In order to fabricate the most efficient sigle-layer DO-PPP LED , we are investigating the structure-property relationship, the effect of the thickness of DO-PPP layer and spin-casting concentration of DO-PPP on the performances, such as brightness versus thickness.

Reference

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3.Xuezhong Jiang and Yunqi Liu, *Synth Met.*, **87**, 175-178(1997)