EFFECTS OF THERMAL ELIMINATION CONDITIONS AND LAYER THICKNESS ON DEVICE PERFORMANCE OF POLY(*P*-PHENYLENE VINYLENE) LIGHT-EMITTING DIODE

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1. INTRODUCTION

Over the past few years, thin film light emitting diodes(LEDs) based on conjugated polymers have attracted much attention.[1] LEDs based on this conjugated systems are of interest due to the ability to fabricate large area, energy efficient devices with tunable light emission(from blue to red light) at a relatively low cost.

Poly(*p*-phenylene vinylene)(PPV), due to its ease of fabrication and light emission in the yellow-green portion of the visible spectrum, has been intensely studied. To date, however, the conditions for the thermal conversion process of PPV and polymer layer thickness in LEDs which affects the conjugation length and light intensity are unknown. The research focus in here is directed to find the optimum conditions for thermal elimination process and the optimum layer thickness.

2. EXPERIMENTAL

Poly(*p*-phenylene vinylene) (PPV) was polymerized following the Swedish researchers[2].

We used the TGA, FT-IR, thin film X-ray diffraction and direct pyrolysis to investigate the thermal conversion process.

The precursor polymer was spin coated with different layer thickness on ITO substrate and heated in the N_2 flowing condition. After this, the negative electrode, Al, was vacuum (10^{-7}torr) deposited to thickness 120nm. Thickness of the polymer layer was measured by α-step surface profilometer. The current-voltage characteristics of the device was measured by Keithly 617 programmable electrometer and the EL light output was measured at the same current density under various layer thickness.

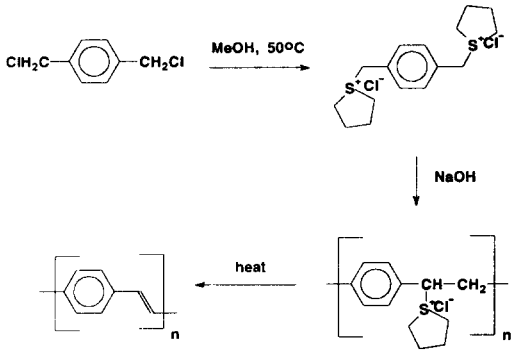

Fig.1. Synthetic route to Poly(*p*-phenylene vinylene).

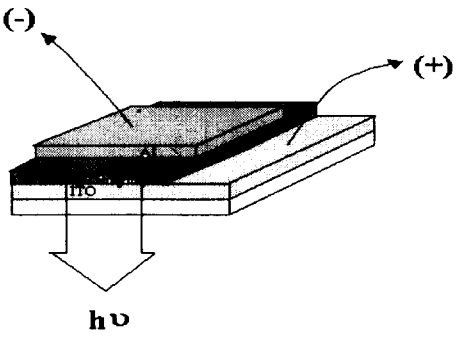

Fig.2. Schematic strcture of the PPV-based LEDs used in this study.

3. RESULTS AND DISCUSSION

The heating temperature of 230°C for 5min. under a nitrogen gas flow of 50ml/min. was an effective heat treatment condition(see Fig. 1). After thermal conversion of precursor polymer, the chains are well packed and the conductivity was increased. During the elimination process, THT, absorbed water, polymer end group were eliminated with the increase of elimination temperature.

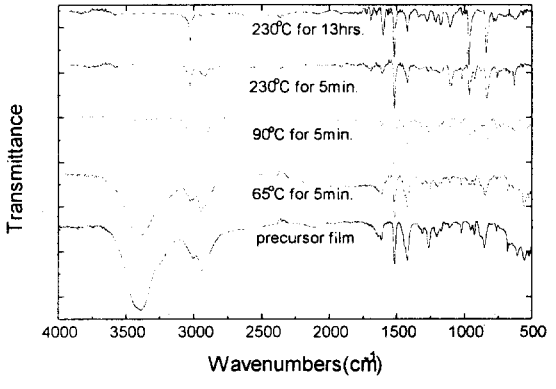

Fig. 3. Infra-red spectrum of precursor polymer treated at different thermal elimination conditions.

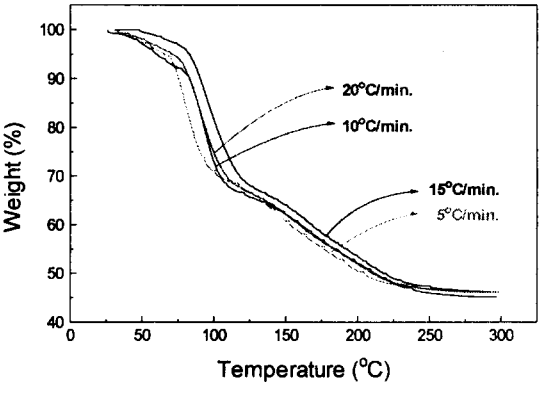

Fig.4. TGA plots of precursor polymer under different heating rates.

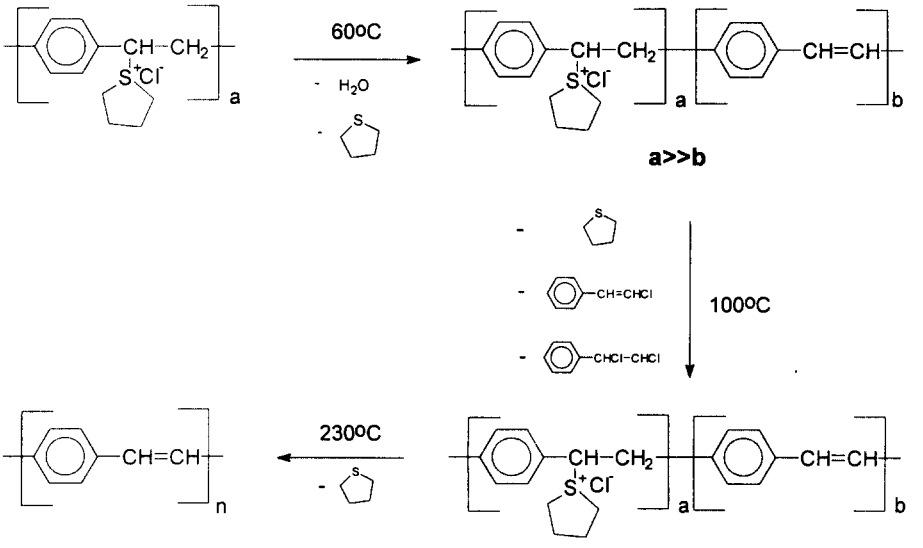

Fig.5. Conversion mechanism of precursor polymer to conjugated polymer.

The optimum thickness of the emitting polymer layer was about 100nm(see Fig. 7). We attribute this result to next explanation. As the films become thicker to 100nm, the amount of leakage current due to defects and imperfections in the film should decrease, so the probability of recombination would increase. But over the 100nm, the absorption is the main reason for the decrease of the light output.

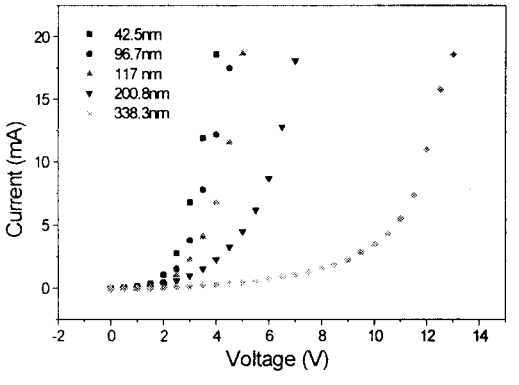

Fig. 6. Thickness dependence of the Current-Voltage characteristics in an ITO/PPV/Al device.

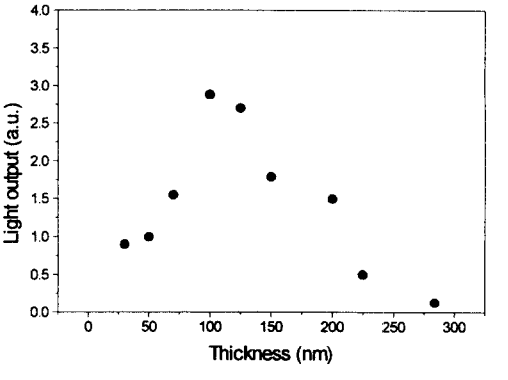

Fig. 7. Thickness dependence of the emitting light output of the PPV LEDs.

4. REFERENCES

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