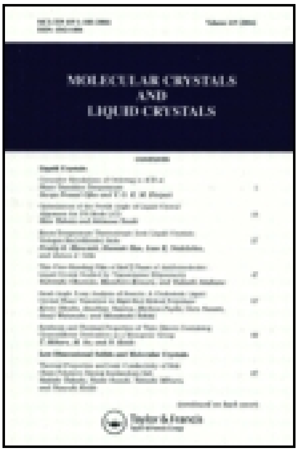

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Photoconduction Effect on PPV and MH-PPV Structures

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ABSTRACT

In this paper we present the photoconduction effect of the poly(*p*-phenylenevinylene) (PPV) and its derivative, the poly[(2-methoxy-5-hexyloxy)-p-phenylenevinylene] (MH-PPV). The structures used to study photoconductivity were prepared using solutions of either PPV-precursor in methanol or MH-PPV in chloroform, both spin-coated on an interdigitated chromium-gold line array previously deposited onto glass substrate. Currents vs. voltage curves were carried out as well as of the films optical characteristics have been studied by UV-Vis, and photoluminescence and eletroluminescent spectroscopies.

Keywords: poly(*p*-phenylene vinylene) and derivatives; photoconduction; diodes.

INTRODUCTION

The development of the technology of polymer light emitting diodes (PLEDs), observed in the recent years, is a proof that these organic materials are candidates to compose optoelectronic devices as active materials. Such applications come from the semiconducting properties exhibited by conjugated polymers, in particular by poly(*p*-phenylenevinylene) (PPV) and derivatives [1,2,3]. The luminescence is generated by a carrier recombination phenomenon that occurs in an instable exciton. However, in contraposition of the recombination efficiency these materials may enhance, by some external excitation, its conductivity due to exciton dissociations. In this paper we present a photoconduction study carried out in PPV and in poly[(2-methoxy-5-hexyloxy)-p-phenylenevinylene] (MH-PPV), which is relevant as a tool to understand the dynamic of the recombination process.

EXPERIMENTAL

The PPV synthesis followed the route developed by Halliday et al [4], whereas MH-PPV was synthesized by a variation of the method developed by Wudl and Srdanov [5,6]. Thin films were prepared using solutions of PPV-precursor in methanol and MH-PPV in chloroform (1% wt). Both polymers were spin-coated (2000 rpm, 60 s) on glass substrates having interdigitated chromium-gold evaporated on its surface under vacuum. This line array was prepared using a lift-off lithographic technique where 25 pairs of them act as electrode contacts. The length of the electrodes, their thickness and the distance between them were 800 µm, 100 µm and 100 µm, respectively. The schematic structure of the device is shown in Fig. 1. After the polymer deposition, the PPV-precursor was heated up to 230 °C for 2 hours under vacuum to obtain the saturated converted-PPV. MH-PPV films were heated up to 50 °C for 30 minutes to eliminate residual solvent from its structure. Absorption spectra were carried out using a Hitachi U-2001 spectrophotometer and photoluminescence (PL) spectra were measured having the sample under nitrogen atmosphere with excitation of 458 nm argon laser. Electrical measurements, I *vs* V and I *vs* t, were carried out using a HP 4145 (Semiconductor Parameter Analyzer) and a Keithley 237 (High Voltage Source Measure Unit), respectively.

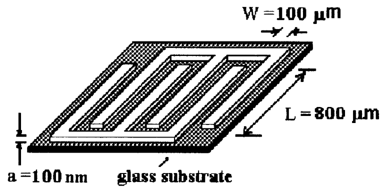

FIGURE 1 Interdigitaded chromium-gold line array on a glass substrate.

RESULTS AND DISCUSSION

Figures 2(a) and 2(b) show the optical characteristics of PPV and MH-PPV, respectively. The absorption curve of PPV presents two main peaks: that around 200 nm that is due to a homo-lumo (H-L) transition, and that at about 400 nm related the aromatic ring due to the conjugated stilbene segments. Its emission exhibits a zero-phonon peak at about 570 nm (yellow region). For the MH-PPV the absorbance peak is around 500 nm and the PL shows the main emission peak at 640 nm (red region). Eletroluminescent spectra were also shown and they are similar to the PL in shape but with lower intensity.

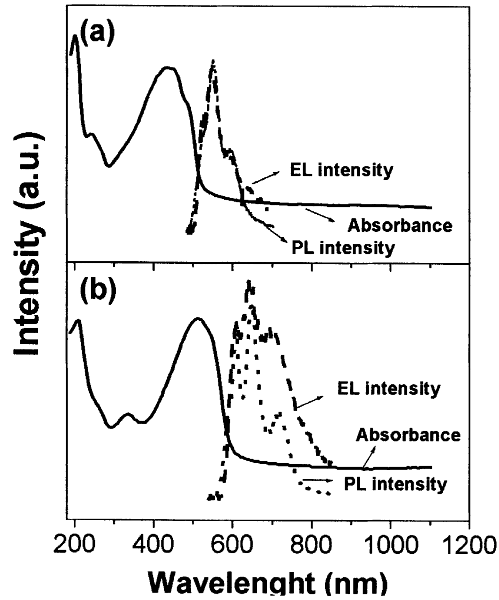

FIGURE 2 Absorption, PL and EL spectrum of the (a) PPV and (b) MH-PPV.

Figure 3 shows the enhancement of the conductivity that occurs in a MH-PPV film (measurement carried out with the structure shown in

Fig. 1) when illuminated with a halogen lamp with intensity of about 250 mW/cm^2. The time delay spent to reach the stationary photoconductivity is smaller than that observed in the decay after the light be turned off. It indicates that both mechanisms are not exactly the same, the dark value being slowly recovered. Similar results were obtained with PPV samples.

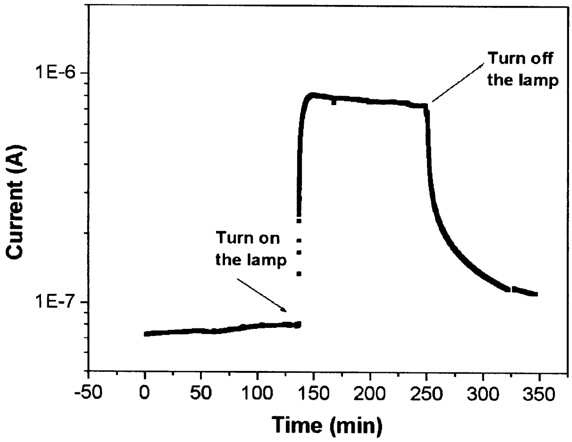

FIGURE 3 Current *vs.* Time curve for MH-PPV structure.

Figure 4a and 4b show I *vs* V curves obtained from device structures of PPV and the MH-PPV, respectively. These results show a perfect ohmic behavior, both in dark and under illumination, in the voltage range of −10 V to 10 V (negative voltages not shown) for both polymers. The photoconduction effect is clear since for PPV the conductivity varies from 6.5 x 10^{-10} $(\Omega m)^{-1}$ in the dark to 3.6 x 10^{-8} $(\Omega m)^{-1}$ under 100 mW/cm^2, while MH-PPV increases from 3.0x10^{-7} $(\Omega m)^{-1}$ to 8.0x10^{-7} $(\Omega m)^{-1}$ at the same conditions. In addition, the slope of the curves increases with the illumination intensity slowing the enhancement of the conductivity with the light exposure.

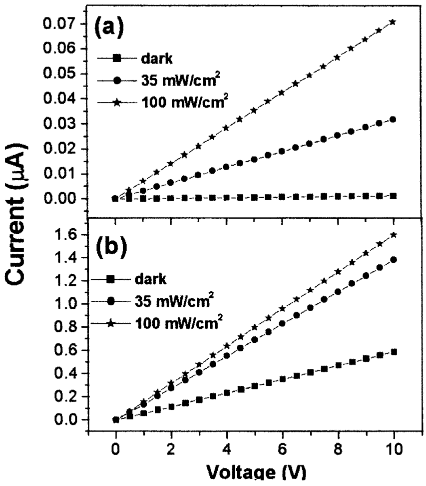

FIGURE 4 Current vs. Voltage at different illumination conditions for (a) PPV and (b) MH-PPV.

CONCLUSIONS

Despite the higher carrier recombination effect observed in PPV and in its derivates, which gives to them the status of high eletroluminescent materials, they also exhibit a photoconduction effect. This effect is shown, for PPV and MH-PPV, in figures 3 and 4. The use of these polymers as light sensors is one possible application of this effect. For this, more detailed researches about the photoconduction effect in function of wavelength and the intensity of incident light need to be carried out. The structure of interdigitates is relatively simple and is already well adapted to thin films of polymers.

Acknowledgements
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