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Photoluminescence of MEH-PPV/PS Blends

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In this work we studied the optical properties of poly[2-methoxy-5-(2'-ethylhexyloxy)-*p*-phenylene vinylene] (MEH-PPV) using polymeric blends with polystyrene (PS). The photoluminescence (PL) spectrum of MEH-PPV present three characteristic peaks correlating to aggregate electronic transition at 608, 674 and 742 nm at 10K. An addition of PS in MEH-PPV films induces a red shift in the absorption spectrum and the PL spectrum presents a new peak at high energy centred at about 572 nm at 10K. It is attributed to intra band transition between localized intraband states.

1 Introduction

The electronic properties of conjugate polymers based on poly(*p*-phenylene vinylene) alkoxy derivatives are extremely sensitive to the chemical synthesis conditions, film processing and photo-oxidation effects. In solid-state films, these materials can aggregate and form excited interchain excitons, responsible for approximate 90% of optical excitations [1,2]. These electronic species act as efficient quenching centres, decreasing the quantum luminescence yields [3]. The control of interchain interaction has been studied by changing molecular conformation in solutions and film processing [2]. It posses a technological interest to enhance the electrical and optical properties of polymeric light emission diodes.

In this work we studied the optical properties of poly-[2-methoxy, 5-(2'-ethyl-hexyloxy) phenylene vinylene] (MEH-PPV) and Polystyrene (PS) blend films. The photoluminescence (PL) spectrum of blend films presents a new well-resolved peak at 572 nm, which is associated with intrachain-localized species. The results show the reduction of the interaction between adjacent MEH-PPV chains without energy and charge transfer.

2 Experimental

Figure 1 shows the chemical structure of MEH-PPV synthesized by Wudl and Srdanov in 1993 [4]. The MEH-PPV and the commercial PS with molecular weight around 60,000 were used to prepare the blends films. Stock solutions of MEH-PPV (0.1 mg/mL) and PS (0.1 mg/ml) in chloroform were mixed in the appropriate proportions (100%:0%, 20%:80% and 0%:100%, respectively) and stirred prior to casting onto glass substrates previously cleaned by the RCA procedure. The films were dried and stored at room temper-

ature, protected from light to avoid photo degradation processes.

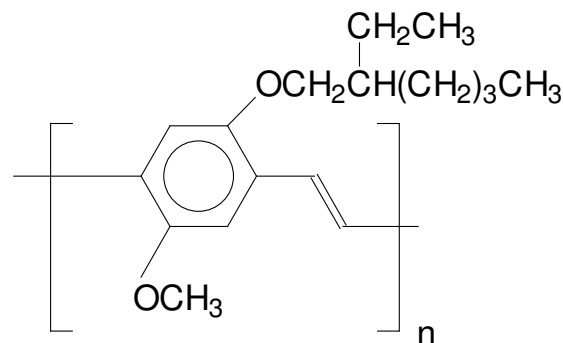


Figure 1. Chemical structure of MEH-PPV.

The UV-Vis absorption measurements were carried out with a Hitachi U-2001 spectrophotometer at room temperature (300K). The photoluminescence (PL) spectra were recorded using a SPEX-750M monochromator equipped with a Jobin-Yvon CCD-detector (2000×800-3) in the range of temperature from 10 to 300K. Excitation was performed with the 457.8 nm line of an Ar⁺ laser. The samples were kept in a closed helium cryostat under vacuum of 10⁻⁴ torr.

3 Results and discussion

Figure 2 shows the absorbance spectra of MEH-PPV, MEH-PPV:PS blend and PS cast films. The films that contain the active polymer present, above 350 nm, an extended band

associated to non-localized states (HOMO-LUMO transitions). The addition of PS in MEH-PPV films induce a red shift (5 nm) in the absorption spectrum, reproducing a solvating effect, reducing the interchain interaction and increasing the effective conjugation length of MEH-PPV main chain [3]. The PL spectrum of the MEH-PPV films present three characteristic peaks correlated to zero-phonon transition at 608 nm and two phonon-replicas at 674 and 742 nm at 10K (Fig. 2). In this case, the zero-phonon transition is attributed to the interchain transition [3]. Following this absorption red shift, the PL spectrum for MEH-PPV:PS film presents a new peak at high energy at about 572 nm (10K), associated with intrachain electronic states [3]. The blends (MEH-PPV:PS) present high thermal stability with weak electron-phonon coupling in the range of temperature from 10 to 300K.

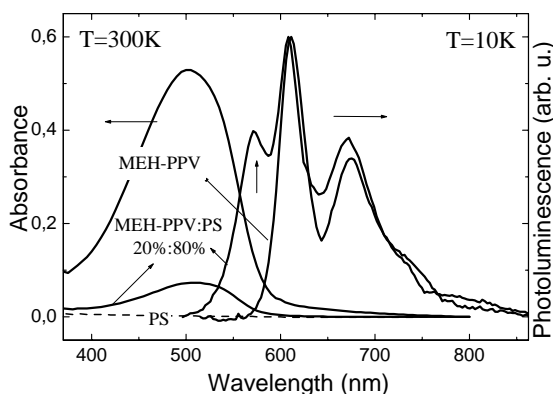


Figure 2. Absorption MEH-PPV, MEH-PPV:PS blend and PS film at room temperature. The PL spectra (10K) of MEH-PPV and MEH-PPV:PS blend films.

The well-resolved peak (PL spectrum – Fig. 2) of MEH-PPV:PS blends film was investigated as a function of excitation intensity (power). In Fig. 3 we show the evolution of the PL spectra at 10K. For excitation intensities being equal 1.2, 3.2, 12.7 and 124.6 $\text{W}\cdot\text{cm}^{-2}$ the PL intensity of the localized peak at 572 nm decreases due to a competition between two distinct radiative processes, or interchain and intrachain transitions. For the excitation intensity above 12.7 $\text{W}\cdot\text{cm}^{-2}$, the line shape of emission spectra does not change and the emission is mainly due to interchain transition. This is coherent with the facility of non-localised electronic state formation via excited states for organic materials. In the case of

conjugated polymer the wave function can delocalise among two or more adjacent chains.

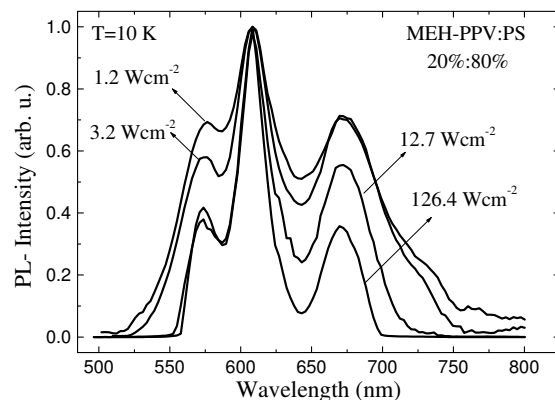


Figure 3. PL spectra of MEH-PPV:PS blend films for excitation intensities 1.2, 3.2, 12.7 and 124.6 $\text{W}\cdot\text{cm}^{-2}$.

4 Conclusion

The MEH-PPV:PS blends films are a promissory alternative to minimizing the interchain interaction during the film processing. This is similar a solvating effect, increasing the effective conjugation length of MEH-PPV main chain and the intraband transition.

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