Syntheses and light-emitting properties of new PPV derivatives containing polyhedral oligomeric silsequioxane

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Abstract

A new light-emitting poly(p-phenylenevinylene) (PPV) derivative containing a polyhedral oligomeric silsequioxane (POSS-PPV) and its MEH-PPV copolymers, [Poly(POSSPV-co-MEHPV)]s, have been synthesized through the Gilch polymerization, and their light-emitting properties were investigated. The synthesized polymers were characterized by NMR, GPC, thermogravimetric and elemental analysis. The POSS-PPV and copolymers showed almost the same optical properties as the MEH-PPV, regardless of copolymer composition. The POSS-PPV and MEH-PPV all showed their peak absorption at 505 and 496nm, and PL emission maxima at 578 and 581nm. POSS-PPV showed higher PL quantum efficiency than the MEH-PPV. Synthesis, characterization and electroluminescent properties of the polymers will be presented.

1. Introduction

Studies of conjugated light-emittung polymers have undergone significant progress sinc the discovery of the first polymer-based light-emitting diode (PLED) [1]. Such studies cover commercial, technological , and scientific interests. One particular type of conjugated polymer, poly(2-methoxy-5-(2-ethylhexyloxy)-p-phenylene-vinylene) (MEH-PPV), has been the subject of a wide spectrum of studies in recent years, going from the optimization of synthetic pathways to device performance.

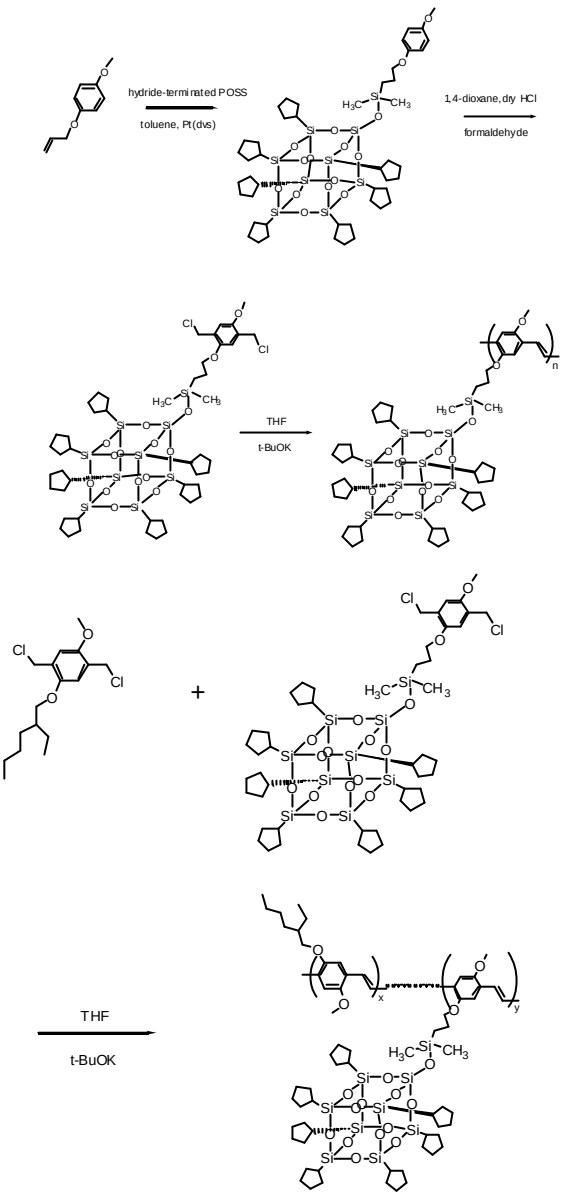
An understanding of the photoluminescence (PL) properties in the solid state is a matter of particular **interest due to its correlation with the efficiency of electroluminescence device. Consensual agreements about** the MEH-PPV photoluminescence mechanisms have been established: (i) the emission of isolated interchain exciton is only possible in dilute solution; (ii) solvents and protocols for film preparation strongly influence the morphology and, consequently, the polymer photophysical properties; and (iii) aggregation depletes the photoemission efficiency [2].

Polyhedral oligomeric silsesquioxanes (POSS), with their unique cagelike structures and nanoscale dimensions, are of particular interest in the field of hybrid materials, and organic-inorganic hybrid polymer systems containing POSS moieties have been used because of the inorganic nature and multiple reactive functionalities of POSS. Incorporation of POSS as a pendant group of a linear polymer increases thermal and mechanical stability of the polymer, including increasing resistance to atomic oxygen in air, and also reduces flammability, density, and viscosity [3].

We report here a novel method for preparing a new type of POSS-PPV organic-inorganic hybrid polymer, in which POSS units are used as a pendant group. This is the first trial that a nanosized POSS unit has been incorporated as a pendant unit of a conjugated polymer. We have studied both the PL and EL from POSS-PPV and found that this polymer shows much stabilized blue emission and high performance.

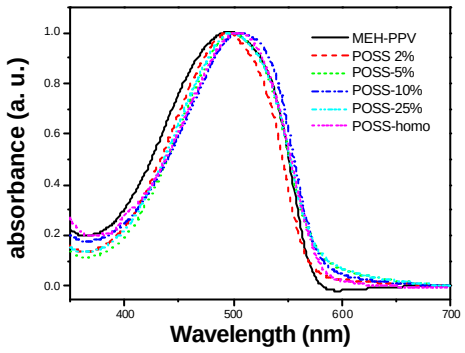
2. Result and Discussion

Our approach is based on utilizing nanosized POSSs which can limit aggregation between polymer chain in the GILCH polymerization . The synthetic procedures for the monomer and the novel POSS-functionalized POSS-PPV are shown in Schemes 1.



Scheme 1.Synthetic routes to the monomer and polymer.

The POSS-PPV and copolymers showed almost the same optical properties as the MEH-PPV, regardless of copolymer composition. The POSS-PPV and MEH-PPV all showed their peak absorption at 505 and 496nm, and PL emission maxima at 578 and 581nm. (figure 1.)



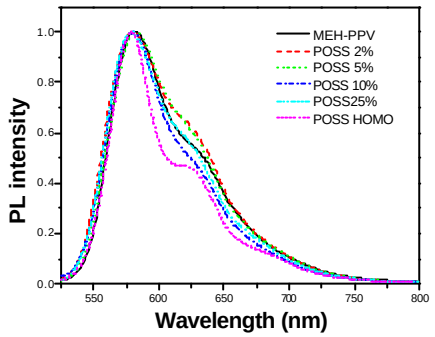


figure 1.PL and UV-vis spectrum of the polymers.

The incorporation of the POSS group inhibited interchain interaction ,which leads to reduce undesired orange-red emission of MEH-PPV and to improve the thermal stability of POSS-PPV. The ITO/PEDOT : PSS/polymer/Ca/Al LED device using POSS-PPV as emitting layer showed a very high light emission with high performance. (figure 2.)

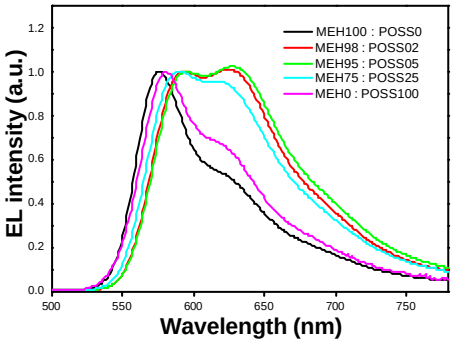


figure 2. EL spectrum of the polymers.

3. Conclusion

A new light-emitting poly(p phenylenevinylene) (PPV) derivative containing a polyhedral oligomeric silsequioxane (POSS-PPV) and its MEH-PPV copolymers, [Poly(POSSPV-co-MEHPV)]s, havebeen synthesized through the Gilch polymerization, and their light emitting properties were investigated. The incorporation of the POSS group inhibited interchain interaction and improved thermal properties. Because of the POSS unit reduced the fluorescence quenching, the fluorescence quantum yields of polymer were also as the POSS ratio increased. The ITO/PEDOT:PSS/ polymer /Ca/Al LED device using POSS-PPV as emitting layer showed a very stable light emission with high performance.

4. References

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