Synthesis and characterization of poly(2,3-diphenyl-1,4-phenylene vinylene) derivatives and composites poly(1,4-phenylene vinylene)/oxide nanoparticles. Optical and electrical properties of the diodes using composite films as active layers

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Abstract

The goal of this research is to study the synthesis and application of new light-emitting polymers. The first part of this study is focused on the synthesis and electro-optical properties of poly(2,3-diphenyl-1,4-phenylene vinylene) (DP-PPV) derivatives. The second part is to study the optical and electrical properties of polymer composites which contain conjugated polymer and oxide nanoparticles.

In the first part, three kinds of DP-PPV derivatives containing liquid crystalline side chains were synthesized. The monomers which contain biphenyl mesogens were polymerized via Gilch route to yield DP-PPV conjugated polymers. All polymers showed a wide range of nematic phase from 172℃ to 290℃. TGA thermogram revealed that polymers possessed high thermal stability. Thin polymer films showed the UV-vis absorption from 361 to 405 nm and photoluminescence (PL) from 500 to 540 nm. A double layer device with the configuration of ITO/PEDOT/polymer/Ca(Al) was fabricated. The device

emitted green light and the threshold voltage was 11 volt. The highest luminance efficiency was 0.79 cd/A. It was also found that the preferential alignment of the polymer thin films could emit polarized light after rubbing, with dichroic ratio of about 2.1.

In the second part, composites made by incorporation of silicon oxide (SiO_2) or titanium oxide (TiO_2) nanoparticles into poly(*p*-phenylene vinylene) (PPV) or poly(2-methoxy-5-(2'-ethylhexyloxy)-1,4-phenylene vinylene) (MEH-PPV) were fabricated. For PPV composites, the UV-vis absorption and PL spectra of the composite films showed a large blue-shift with SiO_2 nanoparticles, but only little difference with TiO_2 nanoparticles. PL spectra also showed an increase in intensity of the high energy shoulder (515 nm) when the concentration of nanoparticles increased. Raman spectra showed a reduction of the 1547/1625 cm^{-1} band ratio in SiO_2 composites but not in TiO_2 ones. These results suggest that SiO_2 nanoparticles reduced the conjugation length of PPV, while TiO_2 nanoparticles did not. Fourier-transform Infrared (FT-IR) spectra showed that both types of nanoparticles reduced the formation of carbonyl groups in PPV main chains. For MEH-PPV composites, nanoparticles have small influence on their optical properties, but they can stabilize the composite films by preventing the fast degradation of PL emission intensity. Current-voltage characteristics measured in ITO-composite-MgAg diodes exhibit different electrical behaviors of the composites depending on the particle size and the nature of the oxide. The composite-electrode contact morphology, the polymer-dielectric particle contact, and the change in the polymer chain length are the possible explanations for these changes in behavior of the diodes. For the study of introduing MEH-PPV into nanopores, blue-shift of photoluminescent emission peak became larger

when the pore size increased. The type of the solvent also has certain influence for the filling process.