INVESTIGATION OF WATER SOLUBLE CONJUGATED POLYMER MPS-PPV

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Conjugated polyelectrolytes (CPEs) are organic semiconductors that are characterized by a π-π conjugated backbone and ionic side groups, which exhibit high solubility in polar media, such as alcohol and water. CPEs have attracted increasing attention for their various potential applications in optoelectronic devices, optical sensors (chemo- and biosensors) [1] and biological imaging [2, 3]. Also, π-π conjugated polyelectrolytes have been extensively studied due to their use in organic light emitting diodes (OLEDs), organic solar cells and organic photovoltaic cells (OPVCs) [3]. One of CPEs is poly(p-phenylenevinylene) (PPV) derivative anionic Poly[5-methoxy-2-(3-sulfopropoxy)-1,4-phenylenevinylene] (MPS-PPV) contains all listed properties thus making it unique due to its versatility. Knowing that MPS-PPV can be used in wide spectrum of application fields ranging from chemical and biological sensors to polymer light-emitting diodes, we concentrate into all basic properties of MPS-PPV that some of them are poorly or even not discussed and suggest new methods for useful applications.

Based on Gilch dehalogenation reaction [1], the MPS-PPV has been synthesized and fully characterized. The structure of polymer and its precursors were confirmed by H^1NMR, C^{13}NMR and Fourier transformation IR (FT-IR) absorption spectroscopy. TGA analysis showed 2-step degradation of MPS-PPV which usually contains about 7-8 % wt humidity. Knowing that MPS-PPV is negatively charged polyelectrolyte and fluorescent in UV light a new method for MPS-PPV molar mass determination was developed by using 0.8% TAE buffer and agarose as matrix. Molar mass was described by polymer mobility in agarose gel comparing with Gene Ruler, 1 kb plus DNA ladder mobility. Electrophoresis was performed applying 6.18 V/cm for ~30 min. According to the electrophoresis test results 20-60 kDa polymer molar mass appeared to be most dominant with long tail until 240 kDa. In the other hand, centrifugal filtration test with 5 different molecular weight cuttoffs showed most concentrated MPS-PPV fraction of 100-300 kDa meaning that MPS-PPV mobility in agarose is higher than DNA ladder standard. Fluorescence of MPS-PPV in DMSO appeared to be 20 times greater comparing with queues solution. Most intense fluorescence obtained at concentration ~10^{-4} M (by monomer units) in both solutions. Reabsorption effect of MPS-PPV can be observed only in DMSO solution diluting from 10^{-3} to 10^{-4} M (by monomer units). Fluorescence kinetics experiment showed 3-step decay mechanism for water solution and 2-step for DMSO solution. Quantum efficiency of MPS-PPV grows form ~7% to ~16% when concentration reduces. MPS-PPV HOMO and LUMO energy levels were measured that are ~5.2 eV and ~3.0 eV, respectively, which is suitable for PLED.

We build FTO/TPD/MPS-PPV/Alq_3/Al polymer LED which showed weak red-orange glow, while improved structure ITO/TPD/MPS-PPV/Alq_3/LiF/Al showed only Alq_3 electroluminescence spectra. Another future application for MPS-PPV could be a new dopant for polypyrrole (PPy) according to application for patent [5]. MPS-PPV could be incorporated in the matrix of PVA and initiator with idea of making the composite layer more conductive and possibly electrically stable (Fig. 1). Also, the deposed polypyrrole using cyclic voltammetry technique (0V to +0.8 V, 100 cycles at 50 mV/s) by addition of MPS-PPV in pyrrole solution appeared 200 times thinner, flatter and mechanically more attached to ITO electrode than PPy layer performed in absence of MPS-PPV (Fig. 1.) in same conditions. This application has tremendous potential to solve adhesiveness problems of electrochemically deposited conjugated polymers and requires more investigation in this phenomenon.

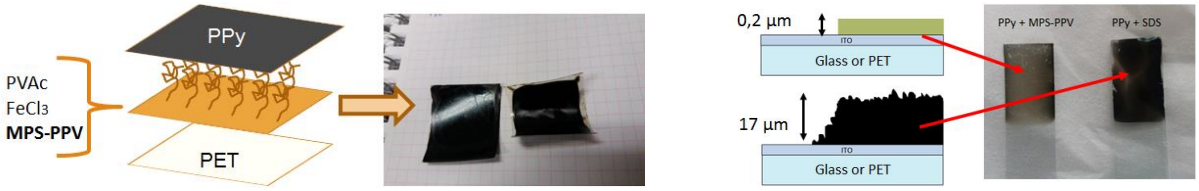

Fig. 1. MPS-PPV application ideas for PPy composite layer and electrochemically synthesized PPy on ITO.

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