Light-emitting Electrochemical Cells with Pulyurethane Ionmer as solid electrolyte

Hsing-Lung Wang and Ten-Chin Wen
Department of Chemical Engineering, National Cheng Kung University, Tainan, 701, Taiwan
E-mail: whl0901@up.che.ncku.edu.tw

Introduction

Since Pei et al. presented the light-emitting electrochemical cells (LECs) in 1995[1], LECs have attracted considerable attentions in recent years. The LECs is composed of a polymer blend layer of conjugated luminescent polymer and polymer electrolyte sandwiched between an anode (usually indium doped tin oxide, ITO) and a cathode (usually Al). At voltages above the energy gap, electrochemical redox and the accompanying redistribution of ions from the electrolyte cause p-type doping near the anode and n-type doping near the cathode. A p-i-n junction is created in-situ and light is emitted from the insulating (i) region between the n- and p-doped layers. Unlike polymer LEDs which utilize the semiconductor properties of non-doped conjugated polymers and electrochemiluminescent cells which utilize the redox properties of luminescent materials, LECs utilize both the semiconductor properties and the redox properties of conjugated polymers.

Polyurethane ionmer had been employed as polymer electrolytes for lithium batteries. Meanwhile these ionmers are easily tailor-designed for the compatibility with luminescent polymers. In this case, it is interesting to blend these polyurethane ionmers with PPV to study the feasibility for light-emitting application.

Results and Discussion

The UV-vis absorption, photoluminescent and electroluminescent spectra of a PPV + PUI film are displayed in Figure 1. The absorption onset is at 515 nm, which corresponds to a LUMO-HOMO band gap (E_g) of 2.4 eV. The photoluminescent spectrum has a strong peak at 507 nm. These spectral features are in good agreement with pure PPV film converted from the precursor at 200 ^oC under inert atmosphere. The PPV + PUI films retain both the characteristics of PUI and PPV, a phase-separated interpenetrating polymer network is preferred in the composite films. The electroluminescent spectrum show the LEC emits green light at 6 V and is close to the photoluminescent spectrum of the polymer layer. Photons are generated by the radiative recombination of holes in the HOMO and electrons in the LUMO of PPV. In contrast to Yin's result [3], no color-shifting effect is observed. There is no interaction between those immobilized anions and electronic species (holes, electrons, and excitons). The PUI/PPV LEC maintains original narrow spectrum width and high luminescent efficiency of PPV, which is feasible for being one color of multi-color display.

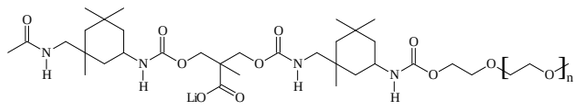
Fig. 2 shows the transient response of the LEC, the turn-on response time is about 100 ms. Similar response time has been reported for Yin's result which the SLEC was based on MEH-PPV+PUI [3]. A typical response time of the conventional LECs based on biionic transport electrolytes is in the range of seconds or even slower. The faster light-emitting response of the LEC may be attributed to the single-ion transport property of the device. Because of the

In summary, we have demonstrated bright LEC using a blend of PUI and PPV as the active luminescent medium. The tailor-designed PUI appears to provide an effective way of producing stable light emission with fast response time which is feasible for commercial application.

References

[1] Q. Pei, G. Yu, C. Zhang, Y. Yang, A. J. Heeger, Science 269 (1995) 1086.
[2] Q. Pei, Y. Yang, G. Yu, C. Zhang, A. J. Heeger, J. Am. Chem. Soc., 118 (1996) 3922.
[3] C. Yin, Y. Z. Zhao, C. Z. Yang, S. Y. Zhang, Chem. Mater., 12 (2000) 1853.

Acknowledgments—The financial support of this work by the National Science Council of Taiwan under NSC90-2214-E-006-024 is gratefully acknowledged.



Scheme 1. The structure of the repeat unit of the synthesized PUI

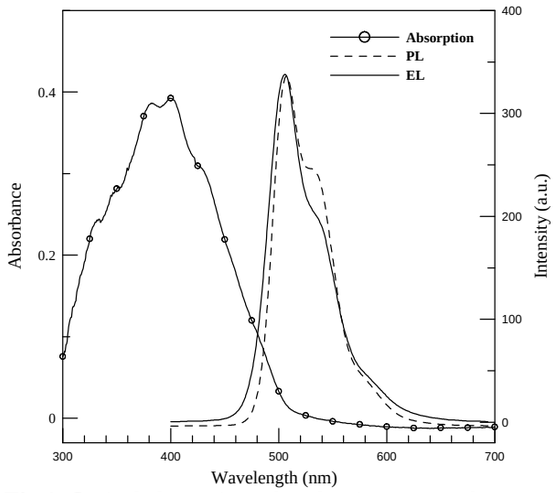


Fig.1. Optical absorption, photoluminescent and electroluminescent spectra of a thin layer of PPV and PUI at the weight ratio of 1:1

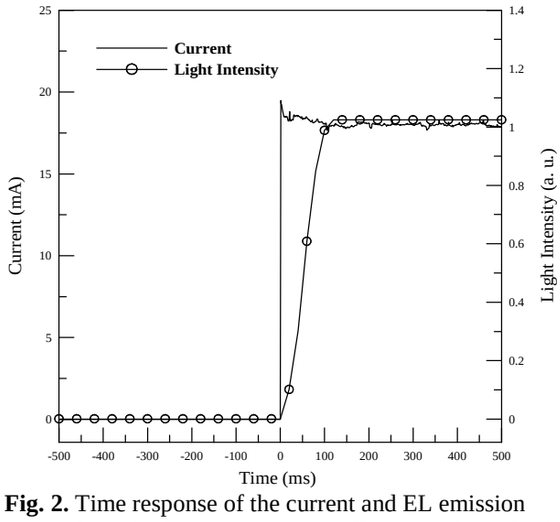


Fig. 2. Time response of the current and EL emission from the [ITO/PPV + PUI/Al] LEC under pulsed excitation