

Poly(2,5-dimethoxyaniline) Based Electrochromic Device

Li-Ming Huang and Ten-Chin Wen
Department of Chemical Engineering, NCKU
Tainan, 701, TAIWAN
E-mail: n3890104@ccmail.ncku.edu.tw

Introduction

Conducting polymer has been extensively investigated in the last 20 years. Recent advances in the field of the conducting polymers have led to a variety of material with greater potentials for practical applications.

Intensified research efforts have been developed on electrochromic devices in recent years, since they can be used for a variety of applications where the light modulation effect can be used [1, 2]. An electrochromic device is an electrochemical cell, composed of optically transparent electrodes coated with complementary electrochromic materials [3] and separated by an electrolyte, which may be liquid or solid.

In the present study, we assembled an all-solid-state sandwichlike structure device with a cell configuration: ITO/PDMA || PEO-LiClO₄ || WO₃/ITO. In this system, the PEO-based electrolyte provides anions to compensate the oxidative doping of the polymer electrode and WO₃ acts as the optically passive ion storage electrode. Cyclic voltammetry was used to characterize the single electrode, ITO/PDMA, ITO/WO₃ and the device. Double potential spectrochronamperometry was used to determine the response time of the coloring-bleaching process of the device. The optical stability at coloring/bleaching state was established. In-situ spectroelectrochemical studies were used to determine the optical contrast of the device.

Results and Discussion

We assembled the device ITO/PDMA || LiClO₄-PC-PEO (400,000) || WO₃/ITO using transparent ITO electrodes coated with a film of oxidized PDMA (green). The area of the electrode was kept as 4.0 cm². Initially, the device was characterized by cyclic voltammetry by cycling the potential in the range -1.5 V to +1.5 V (ITO/PDMA vs. ITO/WO₃). The device is pale yellow at -1.5 V and dark green at +1.5 V. From the charge used for coloring (Q_c, anodic charge) and bleaching (Q_b, cathodic charge) in the device, the coulombic efficiency (CE) was found to be 92 %.

Transmittance spectra recorded at +1.5 V and -1.5 V (Fig. 1) give an optical contrast of 21 % (at 770 nm) for the device which was close to the optical contrast of single electrode (23 %). A double potential step chronamperometry was performed to evaluate the response time of the device and its stability during repeated cycles. Potential was stepped between -1.5 V to +1.5 V with a residence time of 30 s. The optical contrast (ΔT %) at 770 nm was monitored. Fig. 2 represents current-time and % T (770 nm)- time profiles for the device at different repeated cycles. From Fig. 2, it can be seen that for the coloring process the current decay exponentially reaches zero after 16 seconds, whilst for the bleaching process the decay to reach zero current was only 4 seconds. This indicates the

faster dedoping of PDMA⁺ ClO₄⁻ and deinsertion of Li⁺ ion from WO₃. During the bleaching process, the transmittance reaches a value of 68 % within 10.2 s. In the coloration process, the transmittance reaches a minimum value of 43 %. Here again, bleaching seems to have faster response than coloration. This gives an optical contrast of 25 % for the device. The shape of transmittance changes with time during coloring-bleaching processes of the device signify the differences in rate of these two processes. Bleaching process shows a linear change whilst the coloration has a tail at the end of process (Fig. 2).

References

- [1] S. K. Deb, *Sol. Energy Mater.* **1992**, 25, 327.
- [2] C. G. Granqvist, *Solid State Ionics* **1992**, 53-6, 479.
- [3] A. M. Rocco, M. A. Depaoli, A. Zanelli and M. Mastragostino, *Electrochim. Acta.* **1996**, 41, 2805.

Acknowledgments— The authors are grateful to the National Science Council in Taiwan for its financial support through NSC 90-2214-E-006-013.

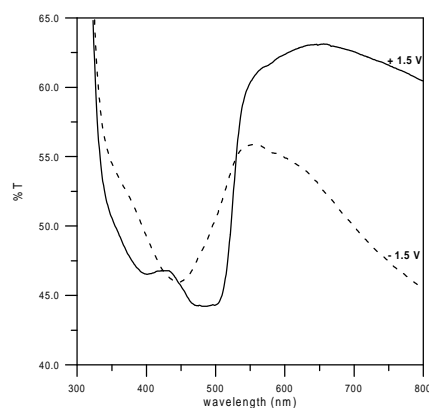


Fig. 1. Transmittance spectra of the device ITO/PDMA//LiClO₄-PC-PEO (400,000)//WO₃/ITO during the voltammetric scan (-1.5 V and +1.5 V).

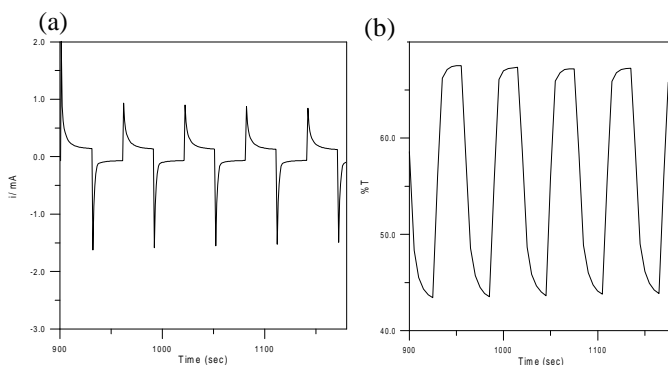


Fig. 2. current - time (a) and Transmittance - time (b) profiles of the device recorded during double step spectrochronamperometry.