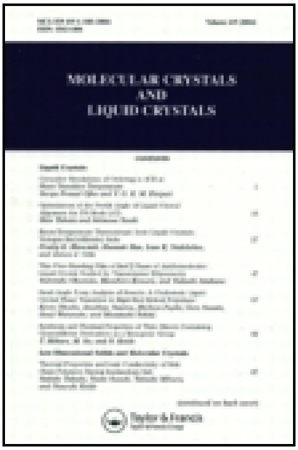

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Li Ion Transport of Conducting Polymer Composite Electrodes

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Li Ion Transport of Conducting Polymer Composite Electrodes

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Li^+ transport of a conducting polymer electrode was investigated using EQCM. This unusual property was conferred to the electrode by the composite formation of conducting polymer P3HT and PSSLi. The electrochemical oxidation was producing the cation radical species on the polymer and forcing the Li^+got out of the polymer. Reduction process allowed the recovery of the lost mass replacing of the Li ions.

Keywords: Conducting polymer; Ion transport; P3HT; PSSLi; EQCM

INTRODUCTION

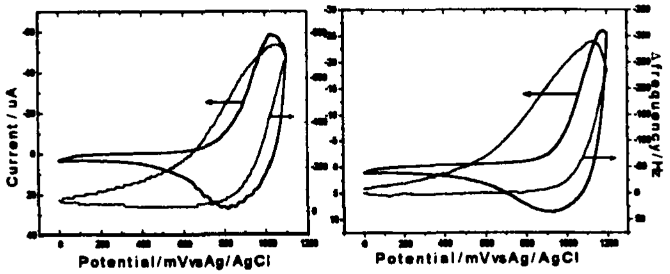
Transport of anion dopant is a well known property of conducting polymers during the electrochemical redox reaction[1]. Electrochemical quartz crystal micro balance (EQCM) shows a mass decrease during the oxidation due to escape of anions and its recovery by the reduction because of the charge neutrality[2]. We applied the charge neutrality principle to preparing a cation transporting conducting polymer using a polymeric anion dopant. In this study, we have blended poly(3-hexylthiophene) (P3HT) and Li salt of poly(styrene sulfonate) (PSSLi) to form a composite having cation transporting property and carefully tested the mass variation during the electrochemical redox reaction.

EXPERIMENTAL

All the chemicals utilized in this study were purchased from Aldrich (USA) and used without further purification otherwise noticed. Preparations of P3HT and PSSLi were reported[3]. Composites having different compositions (mole %, based on monomer numbers) were prepared by blending of P3HT and PSSLi solutions. Each blend was spin-coated on ITO (Samsung Corning, Korea) or on Au electrodes of quartz oscillators (Seiko, Japan). An EQCM system equipped a 9MHz resonator and a potentiostat (EG&G 263) was employed for inducing an electrochemical redox reaction of the composite as well as confirming the mass changes simultaneously. $LiClO_4$/ acetonitrile was used for electrolytes. A Pt counter and Ag/AgCl reference electrodes were used.

RESULTS AND DISCUSSION

The usual anionic transport of P3HT is presentegd in Fig. 1 (a). The cyclic voltammogram(CV) shows a pair of current peaks due to the redox reaction with charging current effect at *ca.* 0.9V vs. Ag/AgCl[4].

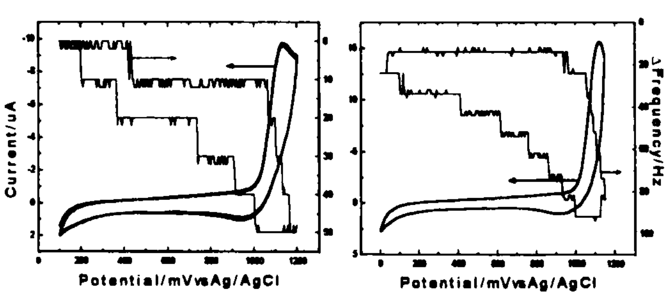


(a) (b)

FIGURE 1. CV withmass change of P3HT (a) and 10% composite(b) electrodes.

The mass increase occurs during the oxidation process and it is recovered by the reduction of this polymer. In Fig.1(b), the 10% composite shows similar behaviors, but the mass change is appearing in a reduced scale. This may be due to the incomplete compensation effect. In other words, only a part of total anion dopants is substituted by the cations (Li^+) in this composite.

In order to make complete compensation, the composite ratio was increased up to 36%. Fig. 2 shows the cationic contribution to the mass change of the composite is very important. The 30% composite shows current peak pair at ~ 1.0V, because the conductivity of this composite is lower than that of 10% composite. As expected, the mass decreas es during the oxidation and the loss is recovered by the consecutive reduction in Fig.2 (a). This mass variation is in completely different direction compared to that of Fig.1. Cations in composites having more than 30% ratio can compensate all the anionic contribution. This is related to the maximum doping ratio of the P3HT. Indeed, the 36%composite shows similar tendency in mass variation Fig.2 (b).



(a) (b)

FIGURE 2. CV and mass change of 30%(a) and 36%(b) composite electrodes.

Fig.3 shows a series of mass change due to a continuous potential cycling. This indicates that the mass change due to the Li^+ transport is reproducible.

In this study, we have shown that the composite formation method can provide the unusal cation transport properties to the conducting polymer. This P3HT/PSSLi composite may be applied to an important Li ions storing electrode in Li ion secondary battery systems.

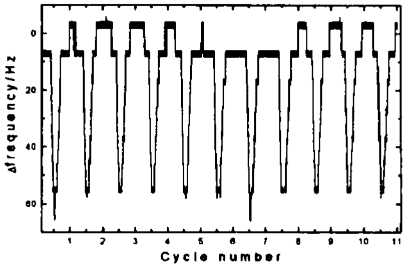


FIGURE 3. Mass responses to continuous potential cycles, 36% composite.

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