Electroactive Polymeric Films from Indole

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Summary: This study establishes necessary experimental conditions for the preparation of electroactive polyindole (PI). Electrochemical behaviour of PI is also reported.

Introduction

Polymer film electrodes prepared by electropolymerization reactions have been the focus of recent research [1-3]. Anodic oxidation of indole has been reported to result in the formation of a black polymeric material (4-11). Polyindole has been shown to possess a conductivity of $5x10^{-3}$ to 10^{-2} ohm^{-1} cm^{-1}, and a structure has been proposed for it [3].

It was thought worthwhile to study electrochemical behaviour of this material. Polyindole formed by continuously cycling the potential produces an electroinactive film. However, polyindole formed at a constant potential produces a film which adheres strongly to the electrode surface and is electroactive. Both thin and thick film electrodes were prepared.

Experimental

Indole was purified by distillation under reduced pressure. No attempt was made to dry acetonitrile. Tetraethylammonium perchlorate was used as the electrolyte. Use of sodium perchlorate gave films that dissolved in acetonitrile.

Cyclic voltammetric experiments were performed in a single compartment cell using a platinum microelectrode (0.0018 cm^2) for film deposition and a platinum wire counter electrode. Silver- silver chloride, saturated potassium chloride, with 2.0 M sodium chloride solution served as the reference electrode. All scans were recorded at 50 mVs^{-1}. To remove oxygen, nitrogen was bubbled through solution for 5 to 10 minutes and a nitrogen blanket was maintained over electrolyte, containing dissolved indole, during film growth.

Following preparation, films were washed thoroughly with acetonitrile before immersion into background electrolyte for cyclic voltammetry. Other details and instrumentation used have been described in literature [12,13].

Results and Discussion

To select potential for growth of film, voltammogram of 50mM indole in 0.1M TEAP solution in acetonitrile (Figure 1) was recorded. The electrochemical behaviour of polyindole film prepared by controlled potential electrolysis at 1.0V for 30 minutes was investigated (Figure 2).

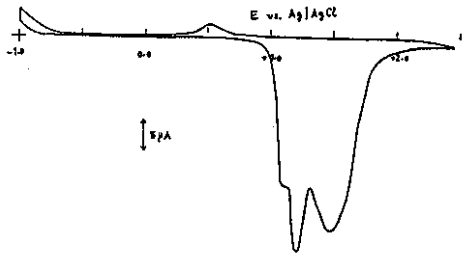

Fig. 1: Cyclic voltammogram of 50 mM indole + 0.1 M tetraethylammonium perchlorate (TEAP) in acetonitrile at platinum microelectrode.

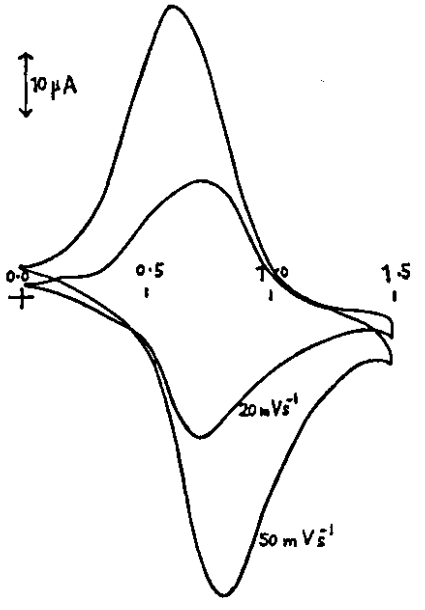

Fig. 2: Cyclic voltammogram of platinum-microeclectrode-coated-with-polyindole in 0.1M TEAP in acetonitrile at 20 and 50 $mVs.^{-1}$

Table 1: Voltammetric characteristics of polyindole-coated platinum electrode, PI/Pt*, in acetonitrile containing 0.1M TEAP

v	ia	ic	ia/ic	Ea	Ec	E**
Vs^{-1}	μA	μA	-	V	V	V
0.200	100.00	100.0	1.00	1.025	0.450	0.575
0.100	70.0	70.0	1.0	0.900	0.525	0.375
0.050	42.5	40.0	1.06	0.775	0.625	0.150
0.020	17.5	16.0	1.09	0.725	0.725	0.00

*Polyindole PI was electrodeposited on a Pt disc, 0.0018 cm^2, from a 50 mM indole solution in acetonitrile + 0.10 M tetraethylammonium perchlorate (TEAP). Electrochemical formation of PI was carried out for 30 min at 1.0 V. Potentials are referred to Ag/AgCl. E** = Ea - Ec.

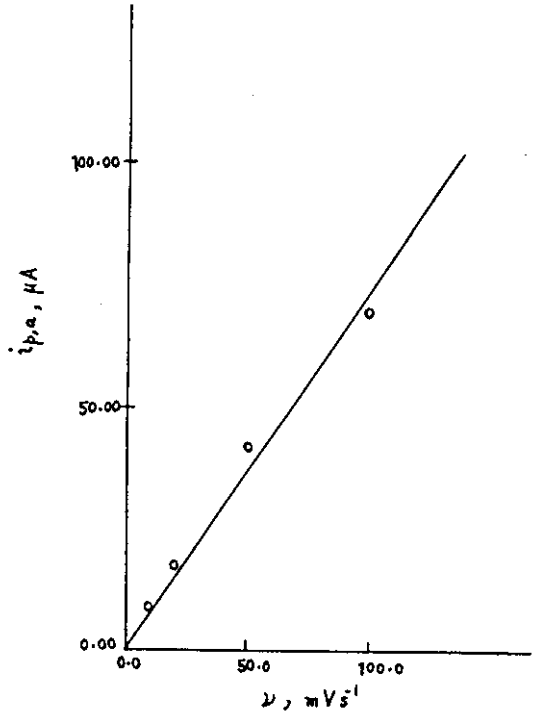

Fig. 3: Dependence of anodic peak current on sweep rate for polyindole.

During electro-deposition, the current increased from 3.5 μA to 10.5 μA, indicating steady growth of the film on the platinum electrode. The i_a and i_c (Table 1) values scale linearly with sweep rate as is expected for the redox reaction involving a surface attached species (Figure 3). Behaviour of thin films, prepared by electrolyzing indole solution for 10 minutes is less well characterised, and response from ferrocene-ferricenium couple was found to be superimposed on the background exhibited by the thin film.

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