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THE DETERMINATION OF DOPAC OVER POLYANILINE-POLY(3-METHYLTHIOPHENE)-POLY(3,3'-DIAMINOBENZIDINE) ELECTRODE

POLİANİLİN-POLİ(3-METİLTİYOFEN)-POLİ(3,3'-DİAMİNOBENZİDİN) ELEKTROT ÜZERİNDEN DOPAC TAYİNİ

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ABSTRACT

3,4-dihydroxyphenylacetic acid (DOPAC) which is important metabolite of dopamine is an important biological molecules [1]. DOPAC with dopamine play an important role in the treatment of neurological disorders such as schizophrenia [2], epilepsy [3], Parkinson's disease [4] Alzheimer [5]. Because of the physiological importance, accurate and reliable determination of DOPAC is important clinically. The redox property of DOPAC allows its electrochemical detection. Various modified electrodes with conductive polymer were used for the determination of DOPAC in the literature [6].

In this study, Polyaniline - Poly(3-methylthiophene) - Poly(3,3'-diaminobenzidine) (PANI - P3MT - PDAB) film which has PANI and P3MT (good conductive polymers) and PDAB (multiple amine functional groups) was potentiodynamically synthesized on Pt disk electrode in methylene chloride layer by layer. For this, green colored PANI film was deposited on Pt disk electrode in methylene chloride containing 100 mM tetrabuthyl ammonium perchlorate (TBAP) / 300 mM aniline / 100 mM HClO4 then black colored P3MT – PDAB film was deposited on PANI film in methylene chloride containing 100 mM TBAP / 500 mM 3-methylthiophene / 1.0 mM 3,3'-diaminobenzidine. Characterization of PANI-P3MT–PDAB film was performed by UV-vis, FT–IR, SEM and EDS methods. This film was used amperometric determination of DOPAC in solution consists of NaHSO4/Na2SO4 (pH 2.0). It was studied at 0.45 V, 0.50 V, 0.55 V and 0.60 V potentials for amperometric determination of DOPAC with this modified electrode. The best analytical data were obtained 0.50 V. Limit of Detection (LOD), Limit of Quantification (LOQ), the linear response range and regression coefficient (R2) were found as 1.47x10-5 mM, 4.49x10-5 mM, 4.49x10-5 – 2.0 mM and 0.981, respectively.

Keywords

Amperometric determination, 3,4-dihydroxyphenylacetic acid, polyaniline, poly (3-methylthiophene), poly (3,3'-diaminobenzidine).

ÖZET

Dopaminin önemli metaboliti olan 3,4-dihidroksifenilasetik asit (DOPAC) önemli bir biyolojik moleküldür [1]. Dopamin ile birlikte DOPAC; şizofreni [2], epilepsi [3], Parkinson [4], alzhemier [5] gibi nörolojik bozuklukların tedavisinde önemli rol oynar. Fizyolojik öneminden dolayı doğru ve güvenilir DOPAC tayini klinik açıdan önem kazanmaktadır. DOPAC'ın redoks özelliği, elektrokimyasal tayinine imkan sağlamaktadır. Literatürde DOPAC tayini için iletken polimerlerden oluşan çeşitli modifiye elektrotlar kullanılmıştır [6].

Bu çalışmada, iyi bir iletken polimer olan Polianilin (PANI) ve Poli(3-metiltiyofen) (P3MT) ile birden çok amin fonksiyonel gruba sahip Poli (3,3'-diaminobenzidin) (PDAB) polimerlerini içeren PANI - P3MT - PDAB polimer filmi metilen klorür ortamda Pt disk elektrot üzerine tabakalar halinde potansiyodinamik olarak sentezlendi. Bunun için ilk olarak 100 mM tetrabutilamonyum perklorat (TBAP) / 300 mM anilin / 100 mM HClO4 içeren metilen klorür ortamında Pt elektrot üzerine yeşil renkli PANI filmi biriktirildi. Daha sonra PANI film üzerine 0.1M TBAP / 500 mM 3-metil tiyofen / 1.0 mM 3,3'-diaminobenzidin içeren metilen klorür çözeltisinde siyah renkli P3MT – PDAB filmi biriktirildi. Elde edilen PANI - P3MT – PDAB filminin karakterizasyonu UV-vis, FT–IR, SEM, EDS metotları kullanılarak yapıldı. Bu modifiye elektrot kullanılarak amperometrik I-t yöntemi ile DOPAC tayini $NaHSO_4/Na_2SO_4$ (pH 2.0) çözeltisinde gerçekleştirildi. Bunun için 0.45 V ile 0.60 V arasında potansiyellerde çalışıldı. En iyi analitik veriler 0.50 V potansiyelde elde edildi. Bu potansiyelde gözlenebilme sınırı (LOD), tayin sınırı (LOQ), lineer cavap aralığı ve regrasyon katsayısı (R^2) sırası ile $1{,}47x10^{-5}$ mM, $4{,}49x10^{-5}$ mM, $4{,}49x10^{-5}$ – 2.0 mM ve 0.981 olarak bulundu.

Anahtar Kelimeler

Amperometrik tayin, 3,4-dihidroksifenilasetik asit, Polianilin, Poli(3-metiltiyofen), Poli (3,3'-diaminobenzidin).

FIGURES/ŞEKİLLER

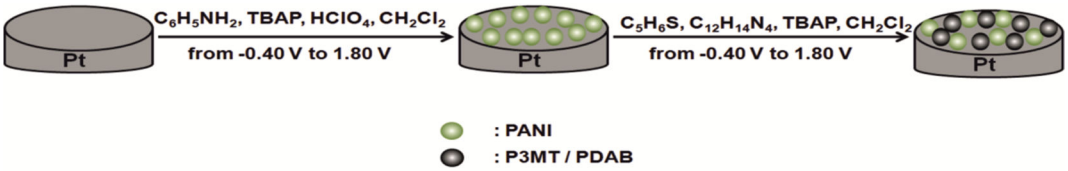

Figure 1. Schematic representation of the deposited PANI – P3MT – PDAB film.

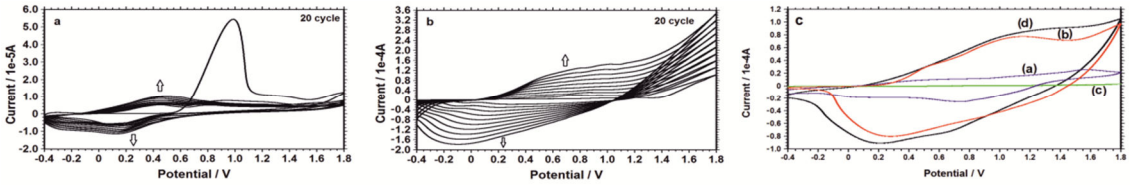

Figure 2. Cyclic voltammograms during potentiodynamic growth of (a) polyaniline film on a platinum disc electrode in 0.10 M tetrabuthylammonium perchlorate 300 mM aniline / 100 mM $HClO_4$, (b) poly(3-methylthiophene)-poly(3,30-diaminobenzidine) copolymer film on polyaniline in 0.10 M tetrabuthylammonium perchlorate / 500 mM 3-methylthiophene / 1.0 mM 3,3'-diaminobenzidine, and (c) cyclic voltammogram of polyaniline-poly(3-methylthiophene)-poly(3,3'-diaminobenzidine) and its homopolymers in blank solution (vs. Ag=AgCl, scan rate:100 mV s^{-1}).

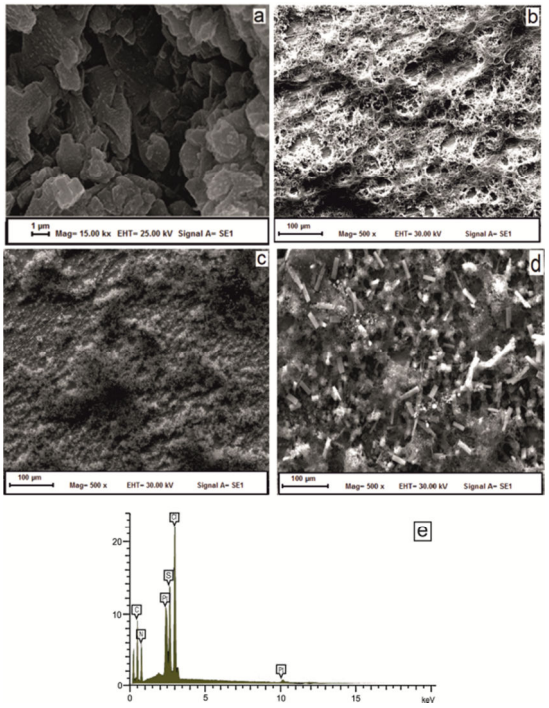

Figure 3. Scanning electron micrographs of (a) polyaniline, (b) poly(3-methylthiophene), (c) poly 3,3'-diaminobenzidine), (d) polyaniline-poly(3-methylthiophene)-poly(3,3'-diaminobenzidine) films and e) Energy dispersive X-ray spectrum of the polyaniline-poly(3-methylthiophene)-poly(3,3'-diaminobenzidine) film.

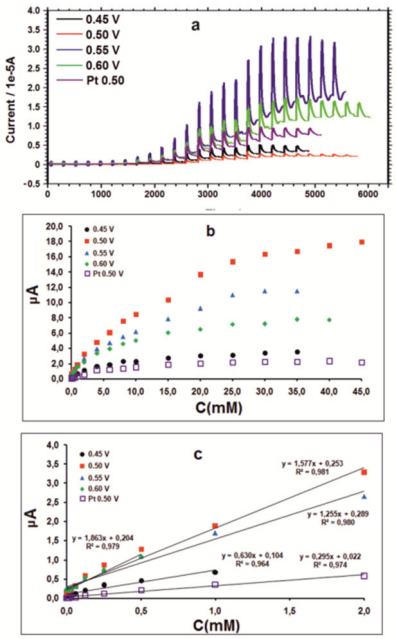

Figure 4. over Pt and PANI / P3MT - PDAB film a) Amperometric I–t curve recorded between 0.45 and 0.60 V vs SCE for various dopac concentrations b) A plot of the steady-state current values measured from amperometric I–t curve vs. the dopac concentration d) Calibration curve for linearity range of dopac concentration.

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