

纳米Pt/聚吡咯/HRP酶共固定微电极传感器及对血清中H₂O₂的快速测定

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摘要:

将聚吡咯(PPy)和辣根过氧化物酶(HRP)以电聚合的方式沉积在微Pt电极($\phi=10\mu\text{m}$)上, 再以电化学沉积法将纳米Pt颗粒沉积在电极表面, 由此制备出纳米Pt/HRP-PPy共固定微电极传感器(Pt/HRP-PPy-nano Pt CME), 研究了其电化学行为。在除O₂的磷酸盐缓冲液(PBS)中, 该电极加速了H₂O₂还原反应, 而沉积在PPy上的纳米Pt显著催化了该反应。以计时电流法定量分析H₂O₂, 在30℃的0.02mol/L pH = 7.0 PBS中检测H₂O₂, 在0.001 ~ 0.3 mmol/L浓度范围呈现线性响应, 相关系数为0.9972, 检测下限达0.3 $\mu\text{mol}\cdot\text{L}^{-1}$ (S/N=3)。该传感器对H₂O₂电流响应灵敏度高(0.42 $\text{mA}\cdot\text{cm}^{-2}\cdot\text{mmol}^{-1}\cdot\text{L}^{-1}$)、迅速(7.3 s)、稳定性好。此传感器表现出Michaelis-Menten行为, K_{Mapp} 为0.033 $\text{mmol}\cdot\text{L}^{-1}$ 。较小的 K_{Mapp} 值表明固定在微Pt电极表面的纳米Pt/HRP对H₂O₂具有较高亲和性。检测了实际人血清样品中H₂O₂, 结果和对照方法一致, 本电极可用作痕量H₂O₂生医传感器。

关键词: 聚吡咯, 纳米Pt, HRP酶, 生物传感器, 微电极

A H₂O₂ Micro Electrode Biosensor Based on Coimmobilized Nano Pt/Poly Pyrrole/HRP for Rapid Determination of H₂O₂ in Human Serum

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Abstract:

One biosensor for H₂O₂ (Pt/HRP-PPy-nano Pt CME) was prepared by polypyrrole (PPy) and horse-radish peroxidase (HRP) coimmobilized on a Pt microelectrode (10 μm) during the polymer growth stage and then electrodeposited by nano Pt. Its electrochemical behavior was studied. In the deoxygenated phosphate buffer (PBS), the electrode showed an accelerated H₂O₂ reduction which is catalyzed by nano Pt particles. The performance of Pt/HRP-PPy-nano Pt CME biosensors were examined by amperometric measurement which gives a linear relationship between response current and H₂O₂ concentration in the range of 0.001 ~ 0.3 mmol/L ($R = 0.9972$), with the detection limit of 0.3 $\mu\text{mol/L}$. Meanwhile, the electrode showed good sensitivity (0.42 $\text{mA}\cdot\text{cm}^{-2}\cdot\text{mmol}^{-1}\cdot\text{L}^{-1}$ in amperometric measurements), rapid response time (7.3 s), and reproducibility for long-term use (the current maintained 95% for at least more than 70 days to 10 $\mu\text{mol/L}$ H₂O₂) in 0.02mol/L pH = 7.0 PBS. The electrode showed Michaelis-Menten behavior at larger H₂O₂ concentrations. The K_{Mapp} values for the sensors was found to be 0.033 $\text{mmol}\cdot\text{L}^{-1}$. The low K_{Mapp} values demonstrated that nano Pt and HRP on microplatinum electrode exhibited a high affinity to H₂O₂. The biosensor shows a good consistency to determine H₂O₂ in real human serum samples with standard method, which indicates it can be used in reality.

Keywords: poly pyrrole ; nano Pt; HRP enzyme; biosensor; microelectrode

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