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Gold Nanoparticle Deposited on Screen-Printed Carbon Electrode for Electrochemical Detection of Nicotine in E-cigarette

Ali Amran, Amirul Aiman[a]; Chin, Lim Ying[a]; Azman, Nurasyiqin[a]; Jafar, Nurfadhilah[a]; Mohd, Yusairie[a]; Rahim, Rosminazuin Ab[b]; Nordin, Anis Nurashikin[b]; Zain, Zainiharyati Mohd[a]

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[a] Electrochemical Material and Sensor (EMaS) Research Group, Faculty of Applied Sciences, Universiti Teknologi MARA, Selangor, Shah Alam, 40450, Malaysia

[b] MEMS-VLSI Research Unit, Department of Electrical and Computer Engineering, Engineering Faculty, International Islamic University Malaysia, Kuala Lumpur, 53100, Malaysia

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Abstract

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Abstract

Nicotine addiction is a global health problem that causes 4.9 million deaths each year. Nicotine addiction from smoking tobacco may harm both active and passive smokers. Due to nicotine's slow electrode kinetics and redox response occurring at positive potentials, there has been a need in designing electrode material for narrowing the electrochemical window for nicotine redox reaction on the current-potential curve. Nicotine oxidation happens at a higher potential making the signal susceptible to interference from oxygen, thus causing inconsistency in the electrochemical signal. Numerous electrode modifications have been attempted to solve the problem of nicotine's substantial overpotential on bare carbon electrodes. In this work, nicotine in e-cigarette tobacco products was detected using gold nanoparticles electrodeposited on screen-printed carbon electrode (AuNPs-SPCE).

The gold solution was prepared from a precursor solution of 10 mM chloroauric acid, HAuCl4. The screen-printed carbon electrode (SPCE) was immersed in the gold solution and was selectively electrodeposited on the SPCE surface at a potential of +0.53 V as the first layer deposition by using chronoamperometry (CA). Then, CA was performed at a constant potential of –0.9 V for approximately 900 seconds on the SPCE surface, resulting in a second layer with gold nanostructures. The gold nanostructures were characterised by using Scanning Electron Microscopy (SEM) and Elemental Dispersive X-ray Spectroscopy (EDX). The electrochemical analysis was proceeded using the fabricated AuNPs-SPCE as the working electrode in potassium ferrocyanide, K4Fe(CN)6, standard nicotine in 0.1 M PBS (pH 7), and liquid-flavoured e-cigarette (sample) using the cyclic voltammetry (CV) method. The effectiveness of the AuNPs-SPCE shows the detection of nicotine at a potential +0.2 V focusing on nicotine's oxidation peak. The oxidation peak calibration graph was linear from 0.00025 M to 0.03 M, with a correlation coefficient (R^2) of 0.9920 and a limit detection of 8.3 mM within 2 secs of response time. This preliminary finding can contribute to the health care community in diagnosing nicotine addiction at an early stage to prevent tragic nicotine overdoses.

Author keywords

electrochemical sensor; electrodeposition, vape; gold nanoparticle; Nicotine

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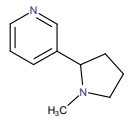

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Zain, Z.M.; Electrochemical Material and Sensor (EMaS) Research Group, Faculty of Applied Sciences, Universiti Teknologi MARA, Selangor, Shah Alam, Malaysia;
email:zainihar@uitm.edu.my

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