

Accepted Manuscript

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PII: S0167-9317(17)30413-6
DOI: <https://doi.org/10.1016/j.mee.2017.12.016>
Reference: MEE 10688
To appear in: *Microelectronic Engineering*
Received date: 16 October 2017
Revised date: 20 December 2017
Accepted date: 21 December 2017

Please cite this article as: Leonidas Madianos, Evangelos Skotadis, Georgios Tsekenis, Lampros Patsiouras, Menelaos Tsigkourakos, Dimitris Tsoukalas , Impedimetric nanoparticle aptasensor for selective and label free pesticide detection. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Mee(2017), <https://doi.org/10.1016/j.mee.2017.12.016>

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Impedimetric nanoparticle aptasensor for selective and label free pesticide detection

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Abstract

An impedimetric label-free aptasensor for the simultaneous and highly selective detection of two pesticides is presented. The sensor is based on the combination of self-assembled platinum nanoparticle two-dimensional films (produced in room temperature via the magnetron sputtering technique) and target specific nucleic acids (a.k.a. aptamers). The platinum nanoparticle films have been deposited on top of SiO₂ substrates previously patterned with interdigitated electrodes. The surface of the device has been chemically modified in order to enhance the subsequent aptamer deposition and immobilization. Two distinctive aptamer configurations have been employed in order to facilitate capturing and detection of two pesticides, namely acetamiprid and atrazine. Successful binding events between aptamer and target induce a shift in the impedance of the aptasensor which can be attributed in charge transport hindrance through the nanoparticle film. The incorporation of the nanoparticle film in the fabrication of the aptasensor significantly improves the performance of the device if compared to “naked” interdigitated based aptasensors, allowing the highly sensitive and selective detection of acetamiprid and atrazine down to 0.6×10^{-11} M and 0.4×10^{-10} M respectively.

Keywords

platinum nanoparticles; pesticides; aptasensor; electrochemical sensor; impedance.

1. Introduction

Today's societies are faced with the twin challenge of feeding a growing population with rising demands, while simultaneously minimizing its global environmental impacts. To that end pesticides and insecticides have been widely employed over the past decades in order to meet the first challenge by improving especially crop yield. However, the result of decades of conventional (as opposed to organic) farming is the environmental accumulation of various non-biodegradable pollutants such as organophosphate compounds (commonly found in pesticides and insecticides), heavy metal ions (Hg²⁺, Cd²⁺, As³⁺, Pb²⁺ etc.), toxic gases (SO₂, NO_x, HCl etc.) and wastewater from residential and industrial areas (phenols, H₂O₂ etc.).

This extensive use of pesticides and insecticides causes concern for their impact on human as well as animal life, which is in direct and indirect contact with hazardous compounds through pesticide accumulation in drinking water and food [1]. It is therefore of the outmost

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