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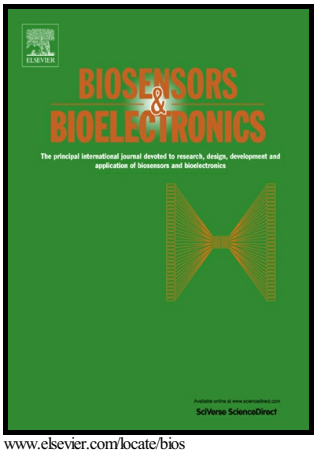

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Gold nanomaterials for the selective capturing and SERS diagnosis of toxins in aqueous and biological fluids

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Abstract

A highly sensitive nanosensing method for the combined selective capture and SERS detection of Microcystin-LR (MC-LR) in blood plasma has been developed. The new method utilizes gold coated magnetic nanoparticles that are functionalized with anti MC-LR antibody Fab' fragments for the selective capture of MC-LR from aqueous media and blood plasma. Using an oriented immobilization approach, the Fab' fragments are covalently attached to gold surface to form a monolayer with high capture efficiency towards the toxin. After the selective capture, the purified MC-LR molecules were released from the extractor nanoparticles within 5 minutes by manipulating the pH environment of the nanoparticles. The regenerated extractor nanoparticles maintained their capture efficiency and, therefore, were re-used to capture of MC-LR from successive samples. The released purified toxin was screened within 10 minutes on gold coated silicon nanopillars and a new paper-based SERS substrate by handheld Raman spectrometer. The SERS enhancement factors of the nanopillars and the new paper-based substrate were $2.5x10^6$ and $3x10^5$ respectively. The lower limit of quantification (LOQ) of MC-LR by SERS on the nanopillar substrate was 10 fM (R^2 = 0.9975) which is well below the clinically required detection limit of the toxin. The SERS determination of MC-LR was cross validated against ELISA. By using antibody fragments that are specific to the target biomolecule, the new methodology can be extended to the rapid extraction and detection of other toxins and proteins.

Keywords: Microcystin-LR, biological fluids, functionalized nanoparticles, antibody fragments, paper SERS substrate, molecular diagnosis.

1. Introduction

Microcystins are a class of more than 50 structurally similar potent hepatotoxins that are produced by the freshwater cyanobacteria (Boaru et al., 2006; Dawson, 1998; Lawton et

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