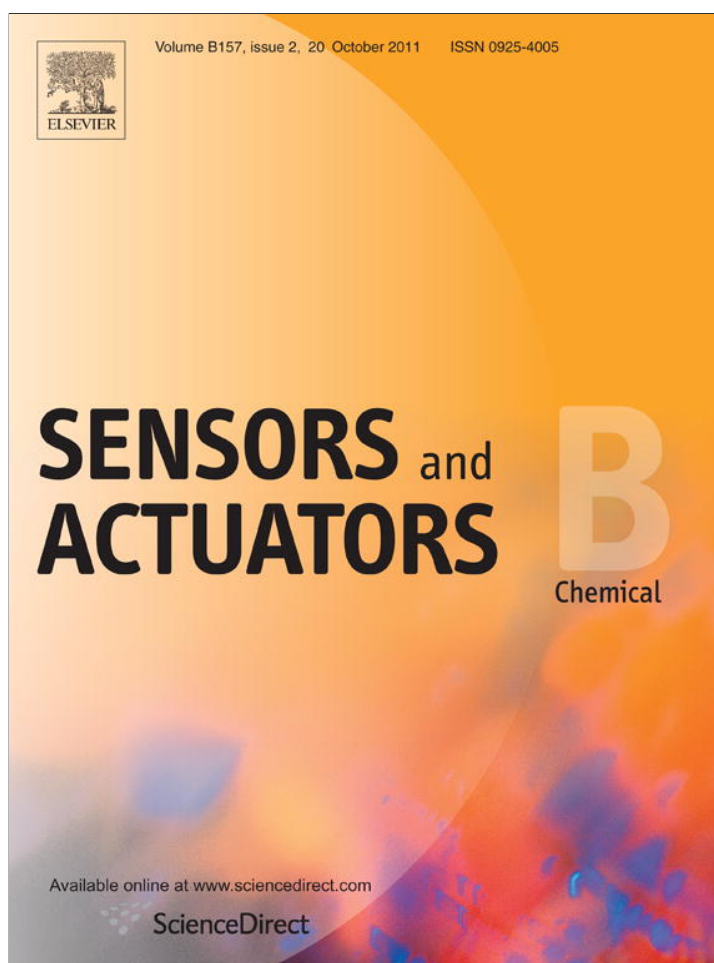


Provided for non-commercial research and education use.
Not for reproduction, distribution or commercial use.



This article appeared in a journal published by Elsevier. The attached copy is furnished to the author for internal non-commercial research and education use, including for instruction at the authors institution and sharing with colleagues.

Other uses, including reproduction and distribution, or selling or licensing copies, or posting to personal, institutional or third party websites are prohibited.

In most cases authors are permitted to post their version of the article (e.g. in Word or Tex form) to their personal website or institutional repository. Authors requiring further information regarding Elsevier's archiving and manuscript policies are encouraged to visit:

<http://www.elsevier.com/copyright>



Contents lists available at ScienceDirect

Sensors and Actuators B: Chemical

journal homepage: www.elsevier.com/locate/snb

Optical fiber chemical sensing of Hg(II) ions in aqueous samples using a microfluidic device containing a selective tripodal chromoionophore-PVC film

Nuriman^a, Bambang Kuswandi^a, Willem Verboom^{b,*}

^a Chemo & Biosensors Group, Faculty of Pharmacy, University of Jember, Jember 68121, Indonesia

^b Laboratory of Molecular Nanofabrication, MESA⁺ Research Institute for Nanotechnology, University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands

ARTICLE INFO

Article history:

Received 15 March 2011

Received in revised form 26 April 2011

Accepted 27 April 2011

Available online 6 May 2011

Keywords:

Optical fiber chemical sensor

Microfluidics

Tripodal

Hg(II)

Water samples

ABSTRACT

A novel methodology for the determination of Hg(II) ions was developed based on optical fiber chemical sensing in a microfluidic device containing a selective tripodal chromoionophore (i.e. tris[2-(4-phenyldiazenyl)phenylamino]ethoxy]cyclotrimeratrylene/TPPECTV)-PVC film. Absorbance detection was performed by incorporating a single optical fiber on the top and the bottom of the detection zone of the microfluidic device. In this micro-sensing system, the intensity of the absorption maximum at 495 nm of the TPPECTV–Hg(II) complex linearly increases as a function of the Hg(II) ion concentration in the range 1.0×10^{-6} to 2.5×10^{-4} M, with a detection limit of 0.5 μ M. Interference from other heavy metal ions was not observed at significant levels. The absorbance results of the detection of Hg(II) ions in environmental water samples (river water) are in good agreement with those obtained by a macro-scale system (cold vapor atomic absorption spectrometry/CVAAS).

© 2011 Elsevier B.V. All rights reserved.

1. Introduction

Miniaturization of chemical analysis provides several advantages over conventional macro-devices. These include: (i) cost reductions via reduced consumption of reagents and cheaper fabrication as well as reduced analysis times, (ii) better control of reaction conditions, (iii) enhanced ability to carry out parallel processing, and (iv) the ability to perform in-the-field or point-of-care measurements [1,2]. In this respect, microfluidics aims to transform the analytical sciences to micro-devices in which chemical and biological processing can take place under precisely controlled conditions [3,4]. These typical devices integrate a series of analytical procedures, such as sampling, sample pre-treatment, chemical reactions, analytical separations, and detection into a single microchip. The last of these steps is often the most challenging, since only small quantities of analyte are usually present in a microfluidic device, and consequently high sensitivity detection techniques are needed.

One of the simple methods for analyte detection in microfluidics is based on “off-chip” detection by coupling a macro-scale optical instrument to the microfluidic device. In common macro-scale optical detection, there are a wide range of applications, i.e. absorbance, fluorescence, and chemiluminescence [5]. In order to couple these into micron-sized detection areas, the use of pinholes

at focus points along the optical fiber is commonly used [6]. This approach gives rise to very low background signal levels, that combined with very sensitive photon detection techniques, such as photomultiplier tubes (PMTs) and charge-coupled devices (CCD) [4,5], in turn, result in very low detection limits. On the other hand, fiber optics represents a suitable method for closely coupling the incoming source and transmitted light in a microfluidic device, because they are amenable to miniaturization. Optical fibers also represent an excellent option for absorption, because they can be used with broadband light sources for simultaneous absorption measurements with wavelength selection achieved at the detector [5,7].

Among the heavy metal ions, Hg(II) is one of the environmentally most important metal ions whose toxicity, even at very low concentrations, is already known for a long time and is a real problem [8]. Therefore, there is a need for analytical methods for the selective, sensitive, and rapid detection of Hg(II) ions in aqueous samples. Different types of chemosensors and chemodosimeters for Hg(II) ions have been reported [9]. A variety of reagents have been used to construct optical sensors and opt(rod)es for mercury ions; a comparison is given in Table 1.

Recently, we developed a novel chemosensor, based on tris[2-(4-phenyldiazenyl)phenylaminoethoxy]cyclotrimeratrylene (TPPECTV) (Fig. 1), for its colorimetric determination [27]. We combined the benefits of a microfluidic system and the excellent properties of the tripodal chromoionophore TPPECTV for the selective binding of Hg(II) ions. In this paper we describe the development of a microfluidic optical fiber chemical sensing system

* Corresponding author. Tel.: +31 53 4892977/80.

E-mail address: w.verboom@utwente.nl (W. Verboom).