

Improved photoelectrochemical detection of mercury (II) with a TiO₂-modified composite photoelectrode

Jessica Chamier ^{a,b}, Andrew M. Crouch ^{c,*}

^a Department of Chemistry and Polymer Science, University of Stellenbosch, Matieland X1, Stellenbosch 7602, South Africa

^b Council for Scientific and Industrial Research, Natural Resources and the Environment, P.O. Box 320, Stellenbosch 7599, South Africa

^c Institute of Molecular Sciences, Faculty of Science, University of the Witwatersrand, Private Bag 3, Wits, 2050, Johannesburg, South Africa

*Corresponding author. Tel.: +27 11 717 6011; fax: +27 11 717 6028.

E-mail address: andrew.crouch@wits.ac.za (A.M. Crouch)

ABSTRACT

The spectrophotometric change of a mercury (II) (Hg²⁺) selective small molecule chemosensor has been successfully converted into a photovoltaic response upon ligating Hg²⁺. The photon excitation was followed by charge separation facilitated by TiO₂ and polyaniline (PANI), resulting in an electron transfer to an electrical back contact. The photoresponse of the Hg²⁺ selective chromophore was converted to an electron current equivalent to the amount of Hg²⁺ in solution. The favourable properties of a Hg²⁺ sensitive chemosensor was combined with the semiconductor capabilities of TiO₂ to construct a sensor that is capable of generating a current in the presence of Hg²⁺ under illumination. A composite of the fluorescent chemosensor rhodamine 6G hydrozone derivative (RS) and PANI was immobilized on indium tin oxide (ITO) plates coated with TiO₂ and subjected to photovoltammetric measurements. The photovoltammetric responses of the coated layers were investigated to determine the sensitivity and selectivity of the immobilized sensor to Hg²⁺ in the presence of background ions. The photo-response increased linearly with increasing Hg²⁺ concentration from 10 to 200 µg L⁻¹ with a limit of quantification (LOQ) of 4 µg L⁻¹. The pH independence for the photoresponse was limited by the TiO₂ layer and was optimal between pH 6 and 7.