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PII: S0039-9140(15)00011-9
DOI: http://dx.doi.org/10.1016/j.talanta.2015.01.006
Reference: TAL15331

To appear in: *Talanta*

Received date: 11 September 2014
Revised date: 4 January 2015
Accepted date: 5 January 2015

Cite this article as: Joseph G. Ayenimo, Samuel B. Adeloju, Inhibitive potentiometric detection of trace Metals with ultrathin polypyrrole glucose oxidase biosensor, *Talanta,* http://dx.doi.org/10.1016/j.talanta.2015.01.006

Inhibitive Potentiometric Detection of Trace Metals with Ultrathin Polypyrrole Glucose Oxidase Biosensor

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Abstract

A method, based on the inhibition of an ultrathin polypyrrole-glucose oxidase (PPy-GOx) potentiometric biosensor response, is described for the detection of Cu^{2+}, Hg^{2+}, Cd^{2+} and Pb^{2+} ions. Based on experimental conditions (0.2 M pyrrole, 500 U mL^{-1} GOx, and an applied current density of 0.05 mA cm^{-2} and a polymerization period of 500 s) previously published by us, PPy-GOx films of approximately 55 nm thick were used to demonstrate the inhibitive potentiometric detection of selected trace metals down to 0.079 μM Cu^{2+}, 0.025 μM Hg^{2+}, 0.024 μM Pb^{2+} and 0.044 μM Cd^{2+}. Furthermore, good linear concentration ranges were achieved for Cu^{2+} (0.079-16 μM), Hg^{2+} (0.025-5 μM), Pb^{2+} (0.10-15 μM) and Cd^{2+} (0.04-62 μM). The analysis of the nature of the inhibition of glucose oxidase in the PPy-GOx biosensor by these metals was achieved by Dixon and Cornish-Bowden plots. The shapes of the curves (exponential decay, parabolic and linear) obtained for the inhibitors suggest that the inhibition by the metal ions may not be exclusively directed at the essential -SH group, but involve additional binding sites of the enzyme. Dixon and Cornish-Bowden plots suggest that the inhibition is competitive for Cd^{2+}, while non-competitive inhibition was observed for other metal ions. The ultra-thin PPy-GOx