Electrocatalytic detection of dopamine at single-walled carbon nanotubes–iron (III) oxide nanoparticles platform

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ABSTRACT

Electrochemical sensors using edge-plane pyrolytic graphite electrode (EPPGEs) modified with singlewall carbon nanotubes–iron (III) oxide (SWCNT/Fe$_2$O$_3$) nanoparticles for the sensitive detection of dopamine (DA) are described for the first time. The surface of the EPPGE-SWCNT–Fe$_2$O$_3$ was characterized using field emission scanning electron microscopy, atomic force microscopy and energy dispersive X-ray spectroscopy while the electrochemical properties were investigated using the cyclic voltammetry, square wave voltammetry and electrochemical impedance spectroscopy techniques. When compared with the bare electrode or electrodes without the Fe$_2$O$_3$ nanoparticles, the EPPGE-SWCNT–Fe$_2$O$_3$ gave best response (7 times more than bare EPPGE and 2-fold more than the other two modified electrodes) towards the detection of DA. Also, the EPPGE-SWCNT–Fe$_2$O$_3$ showed the best analytical performance for DA with an electron transfer rate constant of ~0.26cm$^2$s$^{-1}$, a sensitivity of 3.44µAµM$^{-1}$, a limit of detection of 0.36µM, a catalytic rate constant of $8.7\times10^5$ cm$^3$ mol$^{-1}$ s$^{-1}$, and a diffusion coefficient of $3.5\times10^{-5}$ cm$^2$ s$^{-1}$. This electrode can be reliably used to assay DA in its real drug composition.