Electrochemical Fingerprints of Cocaine and Cathinones on Nanomaterials

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Abstract

Illicit drugs use and abuse remains an increasing challenge for worldwide authorities and, therefore, it is important to have accurate methods to detect them in seized samples, biological fluids and wastewaters.

Nanomaterials have gained much attention over the last decade in the development of sensors for a myriad of applications. The applicability of these nanomaterials, functionalized or not, significantly increases and are therefore highly suitable for use in the detection of drugs of abuse.

We have assessed the suitability of various nanoplatforms for the electrochemical detection of illicit drugs, such as graphene, singled-walled carbon nanotubes, multi-walled carbon nanotubes, gold nanoparticles and platinum nanoparticles. Gold and platinum nanoparticles were deposited by electrodeposition from a solution of chloroauric acid and chloroplatinic acid, respectively, by cyclic voltammetry.

The electrochemical fingerprints of cocaine and cathinones were elucidated on the above-mentioned nanoplatforms. Square wave voltammetry was performed as a high-performance electrochemical method. This allowed for the sensitive and selective (class selectivity) of the investigated illicit drugs.

Methodology

AuNPs were electrochemically deposited directly on the surface of graphite electrodes from a solution of $HAuCl_4$ 5 mM in H_2SO_4 0,5M via CV from 0.2 V to 1.4 V for 20 cycles.

PtNPs were electrochemically deposited directly on the surface of graphite electrodes from a solution of H_2PtCl_6 10 mM in HCl 0.1M via CV from -0.3 V to 1.4 V for 20 cycles.

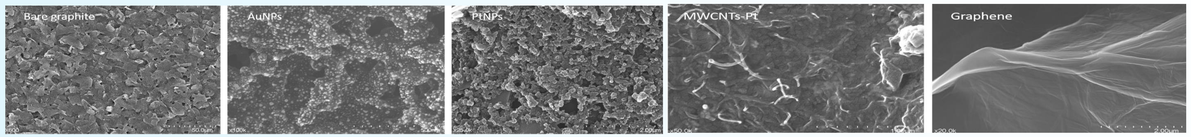
SWV was performed in the potential window of 0 to 1.3V with a step potential of 5mV, an amplitude of 25 mV and a frequency of 10Hz.

Pretreatment was performed by running a CV in H_2SO_4 0,5M in a potential range from -0.5 to 1.5 V with a scan rate of 100 mV/sec.

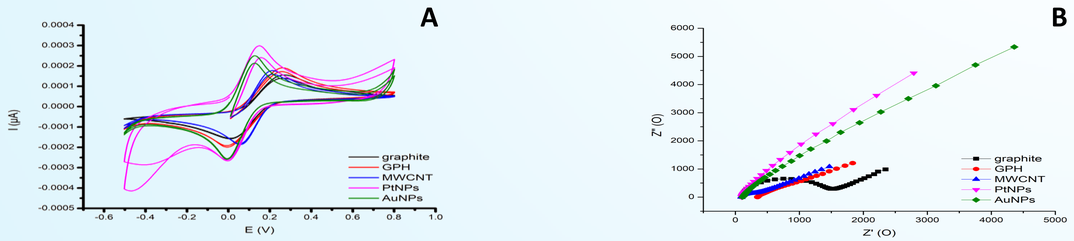
The SWV was also performed on solutions prepared in PBS of chosen pH containing 1% tween.

Results

SEM characterization.

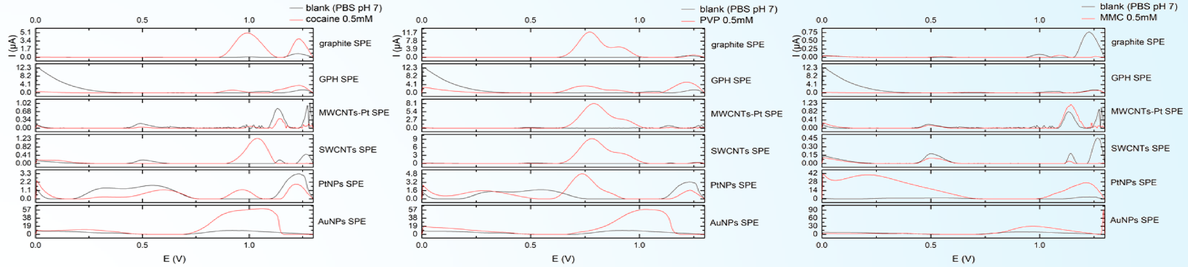


Characterization of the nanoplatforms by cyclic voltammetry (A) and impedance (B).

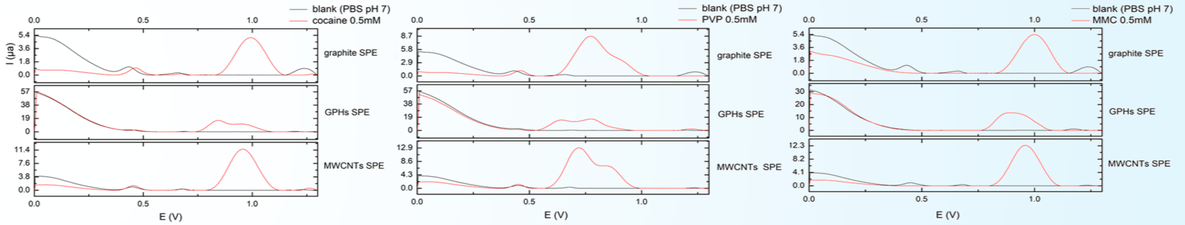


Results

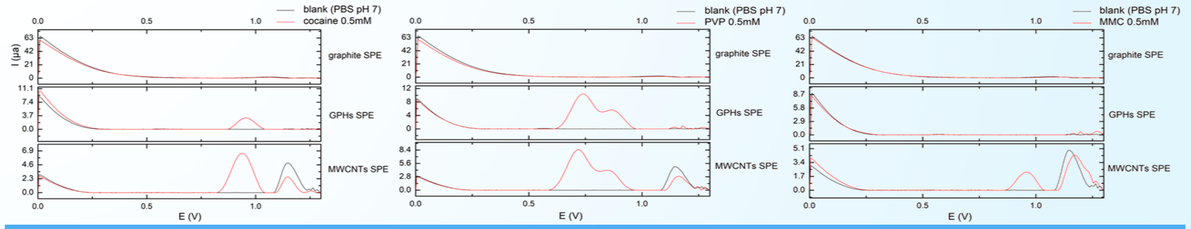
SWV of illicit drugs on graphite and nanomaterial-based platforms in PBS pH 7.



SWV of illicit drugs on graphite and nanomaterial-based platforms in PBS pH 7, after H_2SO_4 0.5 M pretreatment.



SWV of illicit drugs on graphite and nanomaterial-based platforms in PBS pH 7 containing 1% tween.



Conclusion

The best performance was obtained on unmodified graphite electrodes. Although the current peak was lower on nanoplatforms a small shift to more negative potential was observed on graphene and PtNPs.

To improve the performance on nanomaterials, PBS containing Tween 1% was used to reduce the hydrophobicity of the nanomaterials surface. Moreover, a pretreatment of graphene and MWCTs also improved the performance of the sensor leading to an increase in the current peak.

For MMC a signal can be observed after the pretreatment with H_2SO_4 on all platforms and in a PBS solution containing 1% tween on MWCNTs platform.

Acknowledgements

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