Electrochemical Sensor Using Electrodeposited rGO-AuNPs for Adrenaline Detection

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Abstract

Adrenaline (AD), also refers to epinephrine, is a hormone produced in the adrenal glands. AD acts as a neurotransmitter and it is one of the causations for the problems of anxiety, palpitations, high blood pressure, etc. AD exists in sweat, blood and other human body fluids. The measurement of AD is critical for astronauts' stress monitoring.

A composition of reduced graphene oxide and gold nanoparticles (rGO-AuNPs) onto glassy carbon electrode (GCE) was developed through electrodeposition and used for the detection of AD. The detection of AD was performed using differential pulse voltammetry (DPV). The sensor (rGO-AuNPs on GCE) was characterized and optimized through various experiments. An optimal composition was achieved and the optimized sensor on the AD detection presented a limit of detection (LOD) at 70 nM.

Principle and Methods

- GO&HAuCl$_4$ mixture preparation using HAuCl$_4$ and GO solution
- Electrodepositing rGO&Au-NPs on GCE under pH 5.0

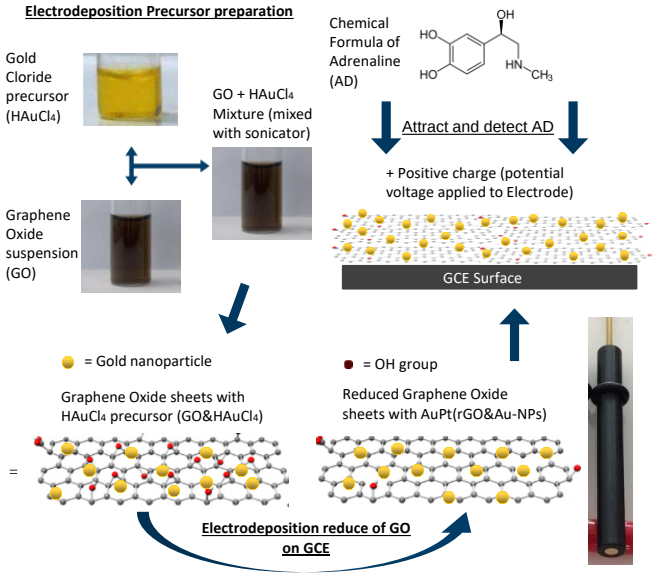

Figure 1. Demonstration of electrodepositing rGO and AuNPs onto the surface of GCE, and the detection of AD using rGO-AuNPs coated GCE.

Experiments

- Optimized the ratios of GO and HAuCl$_4$ concentrations in electrodeposition solutions.
- Determined the pH level of electrodeposition solution based on the solubility and stability of GO&HAuCl$_4$ mixture.
- Optimized electrodeposition conditions and the number of layers of deposition on the basis of the coating roughness and uniformity.
- Optimized pH level of buffer solution for Adrenaline detection.
- Optimized DPV parameters for sensitive detection.
- The sensor was calibrated with the DPV scanning method.

Results

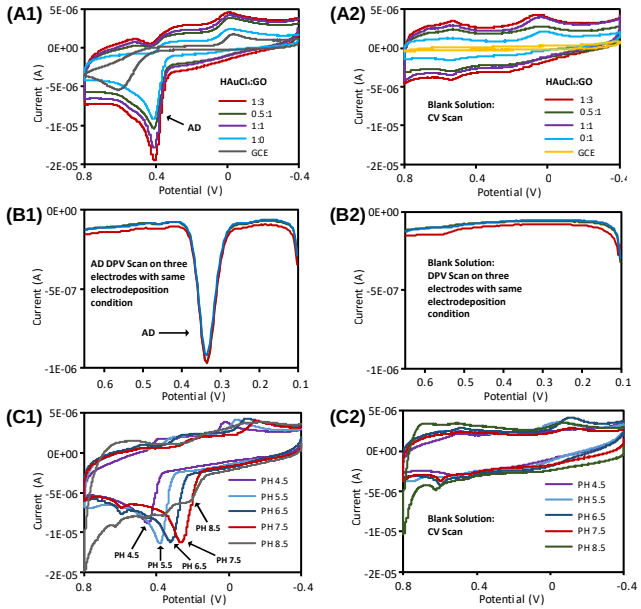

Figure 2. (A) Optimization of the ratios of GO and HAuCl$_4$ concentrations in electrodeposition using cyclic voltammetry (CV); (B) Stability/repeatability tests on the optimized sensor using DPV; (C) pH optimization for sensitive AD detection using CV; (D) DPV parameter optimization for the optimized sensor; (E) The concentration calibration of the optimized sensor on AD detection using the optimized DPV (AD in 0-1000uM concentrations). *Note: In (A1), (B1), (C1) and (D1), the sensors were tested using 0.2 mM AD.*

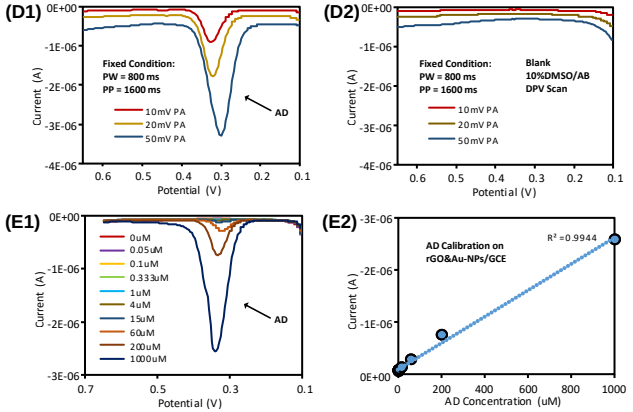

Table 1. Comparison of limit of detections (LODs) on adrenaline using sensors with different sensing materials.

Reported AD detection methods	Techniques	Condition	LOD (uM)	Ref.
P–TiO2	Quenching	PBS (pH 8.0)	0.02	[1]
NT&Au-NPs	Analytical Arrays	PBS (pH 7.2)	20	[2]
NAF-OMC	Amperometry	PBS (pH 7.0)	0.035	[3]
CPE-FePc	DPV	AB (pH 4.0)	0.5	[4]
Poly (caffeic acid)/GCE	Cyclic Voltammetry	PBS (pH 7.7)	0.2	[5]
rGO&Au-NPs/GCE	DPV	AB (pH 5.5)	0.068	This work
Au-NPs/GCE	DPV	AB (pH 5.5)	9.78	This work
GCE	DPV	AB (pH 5.5)	7.0	This work

Conclusions

- rGO&Au-NPs deposition on GCE was investigated and optimized.
- The limit of detection limit of the optimized sensor is ~ 70nM, which is better than that (9.78uM) of Au-NPs electrodeposited GCE and that (7.0uM) of bare GCE.
- We will keep working to develop the sensor towards its wearable format on the basis of our current findings on AD sensing/measurement.

Project Support

- This work is being supported by a Nevada NASA Space Grant NNX15AI02H.

References

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