Modified Glassy Carbon Electrode with Polypyrrole Nanocomposite for the Simultaneous Determination of Ascorbic acid, Dopamine, Uric acid, and Folic Acid

Khadijeh Ghanbari* and Sepideh Bonyadi
Department of Chemistry, Faculty of physics and chemistry, School of Science, Alzahra University, Vanak, Tehran 1993891167, Iran

Graphic abstract

In order to investigate the effect of duration of the cathodic potential application, the potential -2 V was applied at different times of 60, 80, 100, 120, and 140 s to electrodeposition of graphene oxide on the GCE surface. Then, polypyrrole nanofibers (CPC, E=0.8 V, t=150 s) and zinc oxide nanostructures (CPC, E=-0.7 V, t=1200 s) and copper oxide (CPC, E=-0.6 V, t=420 s) were synthesized. Afterward, the differential pulse voltammetric behavior of the modified electrode was investigated in a mixture of AA, DA, UA and FA. The best peaks separation and highest currents observed at the time 100 s and also the potentials of four species have shifted to more negative values. Therefore, the time 100 s was chosen as the optimal time for reduced graphene oxide stabilization.

*E-mail address: kh.ghanbari@alzahra.ac.ir (kh_ghanb@yahoo.com)
DOI: https://doi.org/10.33961/jecst.2019.00472

This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (http://creativecommons.org/licenses/by-nc/4.0) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.
In order to optimization of the polypyrrole nanofibers synthesize time, polypyrrole nanofibers were synthesized by a CPC method and applying the potential of 0.8 V at different times of 50, 100, 150, 200 and 250 s at the surface of RGO/GCE, then zinc oxide nanostructures (CPC, E=-0.7 V, t=1200 s) and copper oxide (CPC, E=-0.6 V, t=420 s) were also synthesized on it. Thenceforth, the differential pulsed voltammetric behavior of the GCE modified with CuO-ZnO/PPy/RGO nanocomposite, was investigated in a mixture of AA, DA, UA and FA. At time 150 s, the potential difference between oxidation peak of AA-DA, DA-UA and UA-FA was highest, and the oxidation peak currents of these four species have also increased due to increased interaction with the modified electrode surface, and the potential of the four species shifted to negative values. At greater times than 150 s, by placing more polymer on the surface of the electrode, its porosity decreases and thus its contact surface decreases with the desired solution, and in subsequent steps, fewer nanoparticles can be synthesized on it. Therefore, the time of 150 s was chosen as the optimal time for synthesis of polypyrrole nanofibers.

For achieving enhanced sensitivity, the zinc oxide nanoparticles were synthesized by CPC method on PPy/ RGO/GCE. For investigating the effect of the cathodic potential application time for the synthesis of zinc oxide
nanoparticles, the potential of -0.7 V was applied at different times of 800, 1000, 1200, 1400 and 1600 to synthesize zinc oxide nanoparticles on the PPy/RGO/GCE. Subsequently, copper oxide nanostructures (CPC, E=-0.6 V, t=420 s) were synthesized. Then, the differential pulsed voltammetric behavior of modified electrode with CuO-ZnO/PPy/RGO nanocomposite were investigated in a mixture containing AA, DA, UA and FA solutions with concentrations 475 µM, 420 µM, 250 µM and 180 µM respectively. As can be seen, the best synthesize time is 1200 s. At this time, the peaks separation and the currents of all four species were the highest, and it is because of increase in the interaction between solutions and modified electrode surface, and the potential of the four species has also been shifted to more negative values.

Sake of optimizing the synthesize time of copper oxide nanostructures, the potential of -0.6 V was applied for copper oxide synthesize at different times of 320, 370, 420, 470 and 520 s on the ZnO/PPy/RGO/GCE. Thenceforth, the differential pulsed voltammetric behavior of a mixture of AA, DA, UA and FA solutions. As can be seen at the time of 420 s, peaks separation is the greatest. Also, the oxidation peak currents of these four species have increased due to the interaction with the modified electrode surface, and the potential of the four species has also been shifted to more negative values. Therefore, in subsequent experiments, this time was selected to synthesize of copper oxide nanoparticles.

---

**Fig. S3.** DPVs at investigation effect of electrodeposition time of ZnO on peak current responses (A) and peak separation (B) of AA, DA, UA and FA on the CuO-ZnO/PPy/RGO/GCE. DPV experimental conditions: pulse amplitude of 50 mV, pulse time of 100 ms, sweep rate of 50 mV s^-1; in 0.1 M PBS (pH 7) containing the mixture of 475 μM AA, 420 μM DA, 250 μM UA and 180 μM FA.

**Fig. S4.** DPVs at investigation effect of electrodeposition time of CuO on peak current responses (A) and peak separation (B) of AA, DA, UA and FA on the CuO-ZnO/PPy/RGO/GCE. DPV experimental conditions: pulse amplitude of 50 mV, pulse time of 100 ms, sweep rate of 50 mV s^-1; in 0.1 M PBS (pH 7) containing the mixture of 475 μM AA, 420 μM DA, 250 μM UA and 180 μM FA.
Fig. S5. Cyclic voltammograms of the 475 µM AA (a), 420 µM DA (b), 250 µM UA (c) and 180 µM FA (d) at the CuxO-ZnO/PPy/RGO/GCE in the range of pH 4.0-9.0 (a to f) respectively, at a scan rate of 100 mV s⁻¹. Inset: Dependence of peak current and peak potential on pH.