A novel highly sensitive carbon based HMPD/GC sensor electrode: Cu (II) ions analysis in flour and drinking water samples

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Keywords: Chemical Sensor Electrode, Surface Modification, Surface Characterization, HMPD/GC Electrode
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Heavy metals pollution has become a serious threat to human health, living resources, and ecological systems. They are not biodegradable and tend to accumulate in living organisms, causing various diseases and disorders to the nervous, immune, reproductive and gastrointestinal systems (Darwish and Blake, 2002; Afkhami et al., 2016). Copper is an essential micronutrient for humans and other creatures. It plays an important role in various physiological processes in organisms such as blood formation, connective tissue development, functioning of a variety of metallo-enzymes and transcriptional events (Que et al., 2008). However, the excessive intake of copper ions through contaminated food and drinking water is highly toxic to living organisms and it may damage the liver or kidney and cause many serious diseases (Veli and Alyüz, 2007; Liu et al., 2016).

Electrochemical methods are based on the direct oxidation or reduction of substrate onto an electrode surface. Electrode reactions are very suitable for analytical applications due to their requirements of high potential. Moreover, these surfaces can be modified by a reductive substrate for analytical applications. Recently, the application of inorganic modified electrodes has increased (Nematollahi and Rahchamani, 2002; Pournaghi-Azar and Nahalparvari, 2005). Modification of carbon surfaces is an important objective in electrochemistry and material science. In electrochemistry, carbon electrodes are widely used because of low background current, low cost, wide potential window, speed, low equipment, chemical inertness and minimum sample pretreatment required prior to analysis (Kuhnau, 1976; Nematollahi and Malakzadeh, 2003).

HMPD, (Z)-2-(2-(hydroxyimino)-2-(3-methyl-3-phenylcyclobutyl)ethyl)-3a,7a-dihydro-1H-isoindole-1,3(2H)-dione molecule was used to modify the surface of glassy carbon electrode and electrochemical behaviour and properties were investigated in this study. Our main goal is to fulfil the quantitative determination of Cu (II) using HMPD modified GC as a sensor electrode. This developed modified sensor electrode was used for the determination of Cu (II) ions in flour and water samples using differential pulse voltammetry, DPV. In this study besides CV and DPV techniques, EIS and SEM techniques were also used for the surface characterization of the modified surface. Cu (II) ions were found to be 1.17×10^{-12} M and 2.74×10^{-12} M in flour and water samples respectively.

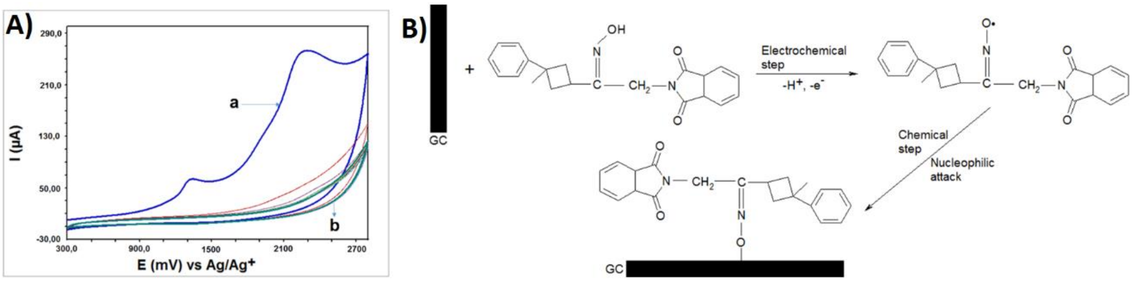

Figure 1. A) Cyclic voltammogram of 1 mM HMPD in 100 mM NBu_4BF_4 (in CH_3CN) vs. Ag/Ag+/(10 mM $AgNO_3$) on bare GC electrode surface. Potential range from +300 to +2800 mV and sweep rate is 100 mV s^{-1}. 1st (a) and 10th (b) potential scan cycle. B) Modification mechanism of HMPD at GC electrode surface.

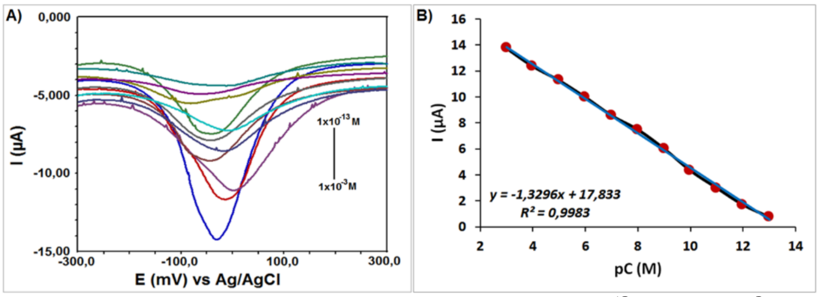

Figure 2. A) DPVs of different concentrations of Cu (II) standards 1.0×10^{-13} M-1.0×10^{-3} M (BR buffer, pH 5.0) solution on HMPD/GC. The measurements were performed in BR buffer solution, pH 5.0, vs. Ag/AgCl/(3 M KCl). Sweep rate was 50 mV s^{-1}. B) Linear relationship between peak currents and different concentrations of Cu(II) ions.

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Acknowledgement

We would like to thank to the Research Foundation of Necmettin Erbakan University, Konya-TURKEY (BAP-131210012) for financial support of this work.